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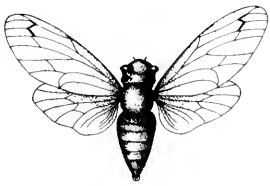

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TWELFTH REPORT

ON THE

Injurious and Other Insects

OF THE

STATE OF NEW YORK

FOR THE YEAR 1896

[From the Fiftieth Report on the New York State Museum]

BY J. A. LINTNER, PH. D., STATE ENTOMOLOGIST

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1897

STATE OF NEW YORK.

No. 50.

IN SENATE,

FEBRUARY 5, 1897.

TWELFTH REPORT

OF THE

STATE ENTOMOLOGIST ON THE INJURIOUS AND OTHER INSECTS OF THE STATE OF NEW YORK.

OFFICE OF THE STATE ENTOMOLOGIST,
ALBANY, *February*, 1897.

To the Legislature of the State of New York:

I have the honor to present to the Legislature my Twelfth Report on the Insects of the State of New York, which is also presented to the Regents of the University, as required by law.

Very respectfully,

J. A. LINTNER.

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REPORT.

OFFICE OF THE STATE ENTOMOLOGIST,
ALBANY, *December* 14, 1896.

To the Regents of the University of the State of New York:

GENTLEMEN.— I have the honor of presenting to your Board my Twelfth Report on the Injurious and Other Insects of the State of New York.

The work of the department has been diligently and successfully prosecuted during the year. A large number of insects have been studied, most of which are of economic importance to the farmer, the fruit-grower, or to the general public. Among these special attention was given to the army-worm in consideration of its distribution and destructiveness throughout the larger portion of the State of New York to an extent not previously recorded. In the pages devoted to the elm-leaf beetle will be found interesting observations upon the long continuance, in successive broods, of the insect in this vicinity — quite at variance with what has hitherto been ascribed to it. Instead of the beetle going into retreat for hibernation in the month of August, the insect has remained with us from its first appearance in May until into November as active larvæ and transforming in its subsequent stages. Quite a number of the insect attacks that have come under observation, have been noticed briefly in "Notes on Some of the Insects of the Year in the State of New York," and others, more fully, in their proper place in the body of the report.

Work upon the classification, arrangement, and labeling of the Collection has been continued. Some progress has been made in the preparation of a biological collection in the limited time that could be spared

for the purpose: A well-arranged collection of this character, exhibiting at a glance the entire life-history, habits, transformations, enemies, etc., of each species, would prove both interesting and instructive to those who apply in person at our rooms for information regarding some special insect pest. The material for such an exhibit has been accumulating during past years, and is only awaiting time for its arrangement.

The additions made to the State Collection have not been as large as those of the preceding year, from the general paucity of insect life, as noticed in a following page. Their number (in part estimated) aggregates about 2,000. Contributions have been received from forty-two persons aggregating about eight hundred examples.

The Tenth Report of the State Entomologist was issued in the early part of July, and forms a part of the Forty-eighth Report of the State Museum. An edition was also printed as separates, for convenience of distribution among agriculturists and entomologists. The report contains 300 pages, 4 plates and 24 figures. Its preparation required an unusual amount of office labor from the extended index given to the ten reports of the Entomologist (1883-1895), occupying 93 pages, and embracing (as estimated) 20,600 references.

The Eleventh Report of the State Entomologist for the year 1895, is now being printed, and will, it is hoped, be ready for distribution before the close of the present year. It will contain nearly 250 pages and 16 plates.

The usual list of miscellaneous publications by the Entomologist during the current year will be found in the Appendix. Forty-one titles are cited with time and place of publication, with a brief summary of each. The aggregate number of such publications listed and abstracts given, in the several volumes of this series of reports, including the present, is 909.

The correspondence of the office during the year has been as follows: Letters received and filed, 1119; letters sent, so far as recorded, 1215.

Arrangement has been made for an amount of additional shelving required by the increase in the collections and library. These additions

will permit a better classification of material, and add greatly to convenience in the frequent reference to both specimens and publications.

In conclusion, I desire to express my appreciation of the aid and encouragement extended by your board during the year past, especially in the recent arrangement through which my department has been brought in closer and more satisfactory relations with your Honorable Board.

Respectfully submitted,

J. A. LINTNER.

INJURIOUS INSECTS.

"Camponotus Pennsylvanicus" and "Formica rufa."

Carpenter Ant and Mound-building Ant.

(Ord. HYMENOPTERA: Fam. FORMICIDÆ.)

In the preceding Report of this series (Eleventh), one of the large ants, *Camponotus herculaneus* var. *Pennsylvanicus*, is represented as sometimes entering dwellings from nests built outside near the house. In one instance mentioned by Dr. Riley, a fine old homestead was so overrun with it that it was on the point of being sold, when the source of the infestation was discovered in a large nest of several feet in diameter in the back yard.

In all probability the above infestation as cited by Dr. Riley was erroneously referred to *C. herculaneus*. Rev. Dr. H. C. McCook, of Philadelphia, who has made special study of the habits of our N. American ants, has modestly questioned the statement in a recent letter received from him:—

"I think that I may venture to question the statement respecting *Camponotus Pennsylvanicus* on page 113. I am reasonably familiar with the habits of this species, and have never known an example of a nest made in the earth, as implied in your statement. It is a carpenter ant exclusively, and lives in trees and timber. I suspect, therefore, that a mistake must have been made in the species. I have occasionally seen the Pennsylvania carpenter ant in houses, but as a rule, it is not inclined to such resorts, and I very much doubt if it could have proved a household pest.

"I make the above statement with some degree of confidence, even though you quote Dr. Riley for your authority. However, if Mr. Theodore Pergande endorses the species, I suppose I should waive my objection, as he is well acquainted with the species of our American Ants."

Dr. McCook has also indicated another error made by me, on page 115 of the Report cited, where *Formica rufa* is given as the "not improbable" annoying occupant of the soil of a lawn on the south side of Long Island, which "during the summer is alive with ants," and also the artificers of large mounds seen by me in the Catskills and in the Shawangunk range at Lake Mohonk. He writes as follows:

"You refer to our American mound-making ants as *Formica rufa*. That is a blunder which I made when I first published an account of the habits of these species in the Transactions of the American Entomological

Society, of 1877. I was misled by Mr. Smith, of the British Museum. Dr. August Forel, however, subsequently corrected my error and described this species as a new one, viz., *Formica exsectoides*. We have *F. rufa* in this country. I have observed and studied it in Colorado, and know that it is found in the Dakotas, but I have no knowledge of its being found in the New England States or in Eastern New York"

In consideration of Dr. McCook's expressed deference to Mr. Pergande's views, his letter was submitted to Dr. Howard, chief of the Entomological Bureau at Washington, who returned the following comments by Mr. Pergande:

"Regarding our mound-making ants I will say that the genuine *Formica rufa* has so far not been found in this country, but that there are numerous forms more or less nearly related to it which occur in different sections of the United States. One of these forms, *F. exsectoides* Forel, appears to be an exclusively eastern species and has so far been found only in Virginia, Pennsylvania, New Jersey and New York, whereas the most common form, occurring in Colorado, Utah, Montana, Wyoming, the Dakotas and Nebraska, is not *F. exsectoides*, as stated by Dr. McCook, but *F. obscuripes* Forel, which up to the present time has not been observed east of the Missouri and Mississippi. As to *Camponotus Pennsylvanicus*, I have never observed it to build extensive nests in the ground, either near dwellings or in the woods, although occasionally I have found small nests under stones near the base of large oak trees which were probably connected with breeding chambers in the large and partly decayed roots of the trees. Most commonly I found them in dead trunks or stumps, generally oak, which had been perforated in all directions by wood-boring larvæ. Whether the ants which Professor Riley observed as having built a large nest in the ground of a backyard in this city really were *C. Pennsylvanicus* or not, I am unable to say. I incline, however, to the belief that they were *Formica subsericea* Say, which has the habit of building large and rather flat nests in the ground."

In the recent "Comstock's Manual for the Study of Insects," *Formica exsectoides* is briefly referred to as being the builder of our largest ant-hills; these are often five or six feet across, and sometimes more than twice that in diameter. The head and thorax of this ant are rust-red, while the legs and abdomen are blackish brown. This species has been supposed to be the same as the European wood ant, *Formica rufa*, and is referred to in many books under that name.

Ecpantheria scribonia (Stoll).

The Great White Leopard-Moth.

(Ord. LEPIDOPTERA: Fam. ARCTIIDÆ.)

STOLL: Sup. to Cramer's Pap. Ex., 1787, fig. 177, pl. 41, fig. 3 (as *Phalena*).

ABBOTT-SMITH: Lepidopt. Ins. Georgia, 1797, p. 137, pl. 69 (as *Phalena oculatissima*).

CLEMENS: in Proc. Acad. Nat. Sci. Phila., xii, 1860, p. 523 (description, distribution).

MORRIS: Cat. Lepidopt. North Amer., 1860, p. 25; Synop. Lepidopt. North Amer. 1862, p. 347 (synonymy, adult and larva described).

HARRIS: Ins. Inj. Veg., 1862, p. 349 (moth and larva described).

SAUNDERS: in Proc. Entomolog. Soc. Phila., ii, 1863, pp. 28–29 (larva described); the same in Canad. Journ., New Ser., viii, 1863, p. 370; Synop. Canad. Arctiidæ, 1863, p. 22; in Canad. Entomol., xiv, 1882, pp. 113–115, figs. 12, 13 (brief general account); in 13th Rept. Entomolog. Soc. Ont. for 1882, 1883, pp. 14–15, figs. 4, 5 (brief general account).

PACKARD: in Proc. Entomolog. Soc. Phila., iii, 1864, p. 127 (bibliography, synonymy, distribution).

RILEY: in Amer. Entomol.-Bot., ii, 1870, p. 179 (larva briefly described), p. 182 (known as "fever worm"); 4th Rept. Ins. Mo., 1872, pp. 141–143, figs. 63, 64 (life-history, description of larva); in Amer. Entomol., iii, 1880, pp. 133–134 (notes on life-history, parasites); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 49 (eating leaves of cotton plant).

STRETCH: Zyg. and Bomb., 1873, p. 174, pl. 7, figs. 20, 21.

SIEWERS: in Canad. Entomol., ix, 1877, p. 128 (feeds on poke berry, will eat cabbage).

FRENCH: in 7th Rept. Ins. Ill., 1878, p. 184 (brief account).

MARTEN: in 10th Rept. Ins. Ill., 1881, p. 116 (brief mention).

SLOSSON: in Entomolog. Amer., iii, 1887, pp. 185, 212 (variety *denudata* in Florida).

EDWARDS, H.: Bull. U. S. Nat. Mus., No. 35, 1889, p. 61 (references)

HARRINGTON: in 20th Rept. Entomolog. Soc. Ont., for 1889, 1890, p. 48, fig. 23 (brief mention).

RILEY-HOWARD: in Insect Life, iii, 1890, p. 155 (*Ophion arctiæ* Ashm. parasitic on).

SMITH: Cat. Ins. N. J., 1890, p. 294 (not rare); in Canad. Entomol., xxii, 1890, p. 179 (bibliography, synonymy); List Lepidopt. Bor. Amer., 1891, p. 27, no. 1122 (listed, synonymy).

DYAR: in Psyche, vi, 1891, p. 127 (at Poughkeepsie, N. Y.); in Canad. Entomol., xxiii, 1891, pp. 106–108 (description of stages).

HOWARD: in Bull. 33 Office Exp. Stat., U. S. Dept. Agricul., 1896, p. 345 (feeding on cotton leaves); the same in Farm. Bull. 47, U. S. Dept. Agricul., 1897, p. 26.

Although this handsome insect is native to the State of New York, the moth is rarely seen. The thickly-haired caterpillars of this and allied species are frequently seen in the autumn crawling rapidly, as though in haste to find suitable shelter for the winter before the setting in of cold weather. This particular species can not be considered injurious in this latitude, as it is comparatively rare, but in some of the southern States it is quite abundant, though not destructive.

The Egg.

Eggs of a moth sent me October 6, 1884, by Mrs. J. P. Ballard, of eastern Pennsylvania, and received by her from Orlando, Florida, proved to be of this insect. They were small, 0.025 inch ($\frac{1}{40}$) in diameter, round, irregularly punctate, changing before hatching from whitish to reddish and finally purplish (Mr. Dyar gives the color as yellowish pearly gray). The duration of this stage was about five days. Less than one-half of the shell was eaten by the larva upon its escape.

While many of the Arctians are known to be quite prolific, this one is markedly so, for Mr. Dyar records an instance in which he obtained 2274 eggs from one individual.

Notes on the Larval Stages.

October 7th. Larva after hatching 0.05 inch long, yellowish, with brown dorsal tubercles on segments 4 and 5 (apodal), 8, 9, 10 and 12, appearing, from above as if two-banded; head reddish, with a conspicuous black spot on each side over the ocelli; hair nearly as long as the body; legs long. Larva feeds readily on plantain.

October 15th. First molting commenced; on the 16th, 10 had molted, and the last on the 20th. Appearance much as before, except that the subdorsal spots on segments 4, 5, 8, 9 and 10 are dark reddish-brown, extending around and below the tubercles — those on segments 4 and 5 also embracing the lateral tubercles, making almost a band upon these segments, except as separated by a pale dorsal line. Terminal segment without brown. Head brownest at the slightly lobed apex. Hairs fuscous, longer than the diameter of the body.

October 19th. Second molt commenced; on 20th, 12 had molted. Length, 0.2 in. Hairs black, about the diameter of body in length. Head pale reddish, a blackish crescent over the ocelli. Body honey yellow. Segment 3 with four brown tubercles dorsally; segments 4 and 5 brown dorsally and laterally; segments 8 to 10, brown dorsally only (over the two subdorsal rows of tubercles). The molting was completed on the

25th, when the earliest had taken the position for the 3d molt, having a length of 0 35 in. The preparation for the molt is made by leaving the plant and selecting a place on the top of the jar containing the larvæ, where each spins a web of three times the area of its body, in which it may securely fasten its prolegs — such attachment being apparently necessary for its successful escape from the cast skin.

October 27th. Third molt commenced. Ended on the 30th. Color dull red. The brown has become black and its area is extending, as segment 3 is also black, in addition to 4, 5, 8 to 10. On the terminal segment (12) the two subdorsal tubercles are shining-black. On the evening of the 31st, the first two took position for the 4th molt — length 0.45 in. With very few exceptions (the result perhaps of disturbance) the larvæ after their molting reverse their position and entirely consume their exuvia.

November 1st. Fourth molt commenced—1 molted; on 2d, 10 molted; on 3d all of previous molt had ceased feeding, and were in position on the lid and sides of the glass jar, for their approaching molt—a few only remained upon the leaves. The molting was completed on the morning of the 5th. Portions of about 20 per cent. of the exuviæ were uneaten. In several instances the larvæ were seen to commence feeding upon the spines, biting them off in small pieces, before attacking the skin. The withdrawal from the old skin occupied about a minute. The spines, first appressed to the body beneath the old skin, appear as wet places, but at once begin to expand and dry. Their final adjustment is apparently hastened by the contortions in which the larva throws itself, by resting on three pairs of prolegs, and with the two extremities raised and curved over the back, almost touching one another, frequently twisting, at short intervals, from side to side. In about an hour after emerging, the meal upon the exuviæ is commenced.

With its longer spines, the caterpillar is now nearly twice as broad as before, but not much increased in length, averaging but 0.5 in. The central and terminal segments are still red, but diminished in extent and less conspicuous than before—the red of the extremities being nearly concealed beneath the long black spines radiating from the tubercles. The legs, prolegs, and ventral surface are red, the plantæ of the prolegs being quite pale—almost a flesh color. The spines on segments 6 and 7 are dusky, interspersed with a few black ones; length of spines equal to the diameter of the body. The head is red with black ocelli, the mandibles black-tipped, and with a few perpendicular black lines on the clypeus. On the 5th the more advanced larvæ show the red ring on the

incisures characteristic of the adult form. On the 6th a larva took position for its molt, on the 7th two others, and ten on the 8th. At this time they measure 0.9 inch in length.

November 8th. Fifth molt commenced—one larva molted; ten more were found to have molted on the morning of the 10th; the last molted on the 15th — the molting of this stage extending over seven days. At the end of this stage they average in length 1.6 in. at rest and 2 in. when in motion. All the spines are black, except some lateral ones in a few individuals, which are brownish; they are minutely barbed to the naked eye and distinctly so under a magnifier (Pl. iv, fig. 1). The segments are black dorsally, except the thoracic and the last two which are a reddish-brown, as are the sides below the spiracles. The red incisural bands commence behind the 4th segment and continue until after the 10th, being seven in number; the central ones being about one-third as long as the black portion of the segment.

November 17. Sixth molt commenced — all the larvæ remaining upon the leaves. The molting terminated on the 23d — continuing six days. In every instance in this molt, the head-case remained attached to the skin. The exuvia shows distinctly a central lateral patch of dusky scales. Fewer of the exuviæ were eaten (26 per cent only), owing doubtless to the stronger and more rigid spines. All the spines are black and all the segments are black dorsally.*

November 25. Seventh molt commenced — terminated on December 4th,—continuing nine days. Length 2.4 inches, at rest; when extended in feeding, 3 inches.

December 1. A caterpillar commenced spinning its cocoon on the side of its feeding cage and the glass cover; for convenience it was transferred to another box. On the 3d inst. a second one had commenced.

December 13. The first pupa was observed, from the caterpillar that had commenced to spin up December 1st. Two more molted on December 14th. On the 30th, the last larva was transferred to a box for pupation.

* If the preceding notes are compared with Dr. Dyar's description of the early stages of this insect (see *Canadian Entomologist*, xxiii. 1891, pp. 106-107), some differences will be detected. Most of these can undoubtedly be accounted for by the natural variations of the species under differing conditions.

TABLE OF LAST TRANSFORMATIONS.

SPUN UP.	Pupated.	Emerged.	Sex.	Pupal period.
December 1	December 13	January 15	....	33 days.
" 3	" 18	" 16	♀	29 "
" 10	" 20	" 18	♀	29 "
" 12	" 21	" 18	♀	28 "
" 12	" 22	" 19	♀	28 "
" 12	" 21	" 19	♀	29 "
" 12	" 22	" 21	♀	30 "
" 12	" 22	" 22	♂	31 "
" 15	" 22	" 20	♀	29 "
" 16	" 24	February 1	....	39 "
" 16	" 25	January 30	....	36 "
" 17	" 25	" 20	♀	26 "
" ?	" 25	" 26	....	32 "
" ?	" 25	February 1	....	38 "
" ?	" 25	" 6	....	43 "
" 17	" 26	" 5	....	41 "
" 19	" 28	January 31	....	34 "
" 19	" 28	February 6	....	40 "
" 19	" 28	" 5	....	39 "
" 20	" 28	January 22	♂	25 "
" 21	" 28	February 2	....	36 "
" 21	" 28	" 6	....	40 "
" 22	" 28	" 11	....	45 "
" 22	" 28	" 14	....	48 "
" 22	" 28	January 26	....	29 "
" 22	" 29	February 13	....	46 "
" 22	" 30	" 5	....	37 "
" 25	" 30	" 7	....	39 "
" 25	" 28	" 1	....	35 "
" 25	" 31	" 10	....	41 "
" 25	January 3	" 20	....	48 "
" 27	" 3	" 17	....	45 "
" 27	" 3	March 4	....	60 "
" 30	" 4	February 20	....	47 "
January 3	" 7	" 25	....	49 "
" 3	" 7	March 1	....	53 "
" 3	" 8	February 17	♀	40 "
" 5	" 12	Crippled	....	.....
" 6	" 12	February 12	♀	31 "
" 10	" 15	" 12	♀	28 "

In the above table is given in detail the time occupied in the last two transformations of forty individuals of this interesting insect within cases which had been kept upon my office table at the State Museum

It will be seen by consulting it, that the shortest period between the spinning up of the larva and pupation was but three days,—the longest fifteen, and the average a little over seven days and one-half. The shortest period of pupation was twenty-five days, and the longest sixty —the average being nearly thirty-eight days.

The Pupa.

The larva spins a thin netting of yellowish silk with little amber beads at the joining of the threads just before pupating. No description of the pupa was made, but it has been described by Dr. Dyar as follows:

"Robust, of normal shape; on the abdominal segments, dorsally and subventrally are ten rows of large tufts of short spiny hairs, the tufts smaller ventrally and less numerous posteriorly; cremaster, two tufts of reddish spines from elevated bases. Color black, reddish in the abdominal incisures; the body is smooth and dull, the wing cases more shiny, creased. Spiracles linear, reddish. Length 35 mm., width 13 mm."

The Imago.

This beautiful insect with a wing-spread of from two and three-quarter inches in the male to three and a half in the female is a desirable addition to the cabinet of a collector. Its lustrous blue abdomen marked with orange down the middle and on the sides, and the sharp black markings of the thorax and wings on a white background, give the insect a striking appearance. There is considerable variation in the markings in different individuals as will be seen on plate 1, and particularly so when the sexes are compared. The irregular black rings that adorn the thorax and wings of the female, tend to become black spots in the male, as seen in figure 2 of plate 1. More often, however, the costal and some of the smaller discal rings on the wings and those of the thorax are replaced by spots (see figures). It will also be noticed that the posterior thoracic spots of the male are frequently blue, while in the female the corresponding marking are a much darker blue or a black.

A variety of this species, *denudata* Slosson, in which the tips of the primaries are invariably denuded, has been described from Florida.

Life-History.

So far as known there appears to be but a single annual generation. The nearly full-grown larvæ are commonly observed in the autumn, and in this stage usually hibernate. The caterpillars can successfully withstand a great degree of cold. They may even be revived after having

been frozen stiff and partially encased in ice. In Kentucky the insect spins up about the first of June and the moths emerge about the 15th. Under exceptional conditions the insect pupates in the autumn and the imago is disclosed before winter sets in.

The only recorded parasite of this species appears to be *Ophion arctiæ* Ashm., which was reared from it at Columbia, S. C.

Food-plants.

The insect is a very general feeder in its travels over the ground as it approaches maturity, and eats from almost any plant that it chances to meet with except the coarser ones. It will also climb low trees and feed on the foliage. Among its favorite food plants are some of the Compositæ, the wild sun-flower (*Helianthus*) being one commonly eaten by the larva. It has also been recorded as feeding on the willow, poke berry, and black locust in nature. In confinement it has been reared successfully on cabbage, the plantain, castor bean (*Ricinus communis*), and the spurge (*Euphorbia cyathophora*).

Distribution.

This insect has a wide distribution, being comparatively abundant throughout most of the northern United States and in many parts of Canada. In some of the southern swamps it is quite common, and in those regions it has been known as "Fever-worm" among the negroes from a mistaken impression that this caterpillar is the cause of the ague.

An Innoxious Insect.

The injuries resulting from this insect are seldom, if ever, serious, as it is nowhere known as a common pest, and it rarely causes any damage worthy of notice. This would naturally result from their restlessness. which does not allow them to remain long in one place, and from their food consisting largely of comparatively valueless plants.

Leucania unipuncta (Haworth).

The Army-Worm.

(Ord. LEPIDOPTERA: Fam. NOCTUIDÆ.)

COMSTOCK: Rept. upon Cotton Insects, 1876, p. 11 (mention), pp. 101, 106 (mistaken for *Aletia*), pp. 202, 203 (*Nemorœa leucaniæ* and *Exorista flavicauda* valuable parasites of *Heliophila unipuncta*).

SMITH: in Rept. upon Cotton Insects, 1879, p. 259 (*Leucania unipuncta* attracted to sweets); Cat. Ins. N. J., 1890, p. 316 (common all over the State); List Lepidopt. Bor. Amer., 1891, p. 46, no. 2280; in Rept. N. J. Agricul. Expt. Stat. for 1890, 1891, pp. 514–515. figs. 27, 28 (remedies); in Entomolog. News, vii, 1896, p. 204 (brief notice of ravages in 1896); Economic Entomol., 1896, pp. 294–296, figs. 332, 333 (brief general account); in Rept. N. J. Agricul. Expt. Stat. for 1896, 1897, pp. 433, 434, 449–457, figs. 1–5 (recent injuries in N. J.; general account).

HICKS: in Amer. Entomol., iii, 1880, p. 227 (ravages in Queens Co., N. Y. in 1880).

LINTNER: in Country Gentleman, for July 1, 1880, xlv, p. 424 (eggs identified); in id., for June 2, 1881, xlvi, p. 359 (reference); 1st Rept. Ins. N. Y., 1883, pp. 33, 53 (remedies), pp. 100, 127, 128, 132, 134–135, 146, 147, 226, 312–313, 314 (references); 2nd do., 1885, pp. 43–44 (injuries in N. Y.); 4th do., 1888, pp. 139, 163 (references); 6th do., 1890, pp. 176, 179–180 (references); 7th do., 1891, pp. 373, 376 (references); in Country Gentleman, for October 6, 1892, lvii, p. 750 (remedies); 8th Rept. Ins. N. Y., 1893, pp. 265, 293 (references); 9th do., 1893, p. 443 (reference); in Country Gentleman, for June 29, 1893, lviii, p. 508 (reference); 10th Rept. Ins. N. Y., 1895, pp. 482, 490, 519 (references); in The Argus [Albany, N. Y.], for July 8, 1896, p. 8 (ravages in N. Y., remedies); the same, in part, in the New York Recorder, for July 15, 1896; in Country Gentleman, for July 16, 1896, lxi, p. 552; in Rome Sentinel, for July 10 and 17, 1896; in Circular of the Department of Agriculture of the State of New York; in New York Daily Tribune, for July 18, 1896 (injuries in Eastern N. Y., remedies); in Country Gentleman, for July 23, 1896, lxi, p. 574 (extent of injuries, remedies); in id., for August 6, 1896, lxi, p. 606 (ravages at Orchard Home, N. Y., remedies); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, pp. 55–56 (ravages in New York).

MANN: in Psyche, iii, 1880, pp. 91, 93, 115, 118 (references to ravages of army-worm in Mass. and vicinity), 1881, p. 226 (reference); in do., iv. 1884, p. 210 (reference).

DIMMOCK: in Psyche, iii, 1881, pp. 212, 282 (numerous references to ravages in New England and Nova Scotia), pp. 287, 345 (references); in do., iv, 1885, p. 295 (reference); in do., v. 1888, p. 141 (reference).

SAUNDERS: in Canad. Entomol., xiii, 1881, pp. 198–199 (in Ontario and Western States); the same in Ann. Rept. Entomolog. Soc. Ont. for 1881, 1882, p. 6.

THOMAS: 10th Rept. Ins. Ill., 1881, pp. 5–43, figs. 1–5 (extended account).

COQUILLETT: in 11th Rept. Ins. Ill., 1882, pp. 8, 49–64 (habits and life-history).

GODING: in Trans. Iowa State Agricul. Soc. for 1882, 1883, separate, p. 9 (brief account).

COOKE: Inj. Insects Orch.-Vineyard, 1883, pp. 282–283, figs. 269–271 (brief general account).

FORBES: in Trans. Miss. Valley Horticul. Soc., 1883, separate, p. 7 (strawberries stripped of leaves by army-worms); 12th Rept. Ins. Ill., 1883, p. 102, fig. 22 (ravages in Ill.); 13th do., 1884, pp. 9, 40, 61, 84, pl. VI, figs. 1, 2 (notes on habits, remedies); 14th do., 1885, p. 5 (mention); 15th do., 1889, pp. 2–3 (mention, as *Heliophila unipuncta*); 16th do., 1890, p. ix (mention); Append. to 17th do., 1891, pp. 25, 35 (references to Le Baron); 18th do., 1894, pp. x, 14 (mention); 19th do., 1896, p. 76 (experiment on larvæ).

REED: in 13th Ann. Rept. Entomolog. Soc. Ont., 1883, p. 52 (*Nemoræa leucaniæ* a parasite).

RILEY: in 3d Rept. U. S. Entomolog. Comm., 1883, pp. 89–156, pls. I, II (an extended account); in Canad. Entomol., xv, 1883, p. 173 (duration of transformations); the same in 14th Ann. Rept. Entomolog. Soc. Ont., 1884, p. 19; 4th Rept. U. S. Entomolog. Comm., 1885, p. 19 (mistaken for *Aletia*), pp. 350-351, pl. V (brief account), Append., p. [102] (note on appearance); in Insect Life, iii, 1890, pp. 183–184 (mention); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, pp. 41, 54, 57 (exhibit of at World's Columbian Exposition); in Insect Life vi, 1894, p. 222 (living examples in Mexican cereals at World's Fair).

FERNALD: in Kingsley's Stand. Nat. Hist., ii, Crust. and Ins., 1884, p. 451, figs. 568, 569 (brief notice, both as *Heliophila* and *Leucania unipuncta*); in 34th Ann. Rept. Mass. Agricul. Coll., 1897, p. 186 (mention).

HUBBARD: in 4th Rept. U. S. Entomolog. Comm., 1885, Append., p. [6] (not in Florida).

VAN DUZEE: in Canad. Entomol., xvii, 1885, p. 80 (*Aphis mali* attracting *L. unipuncta* moths).

WEBSTER: in Ind. Agricul. Rept. for 1885, 1886, separate, p. 18, pl. 4, figs. 2, 3 (injuring corn); in Insect Life, iii, 1890, pp. 112–113 (in Indiana, ovipositing in corn); in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, pp. 45–46 (damages in Ind., parasites); in Insect Life, vi, 1893, p. 150 (but one brood injurious in Ohio); the same in 24th Ann. Rept. Entomolog. Soc. Ont., 1894, p. 89; Bull. 51 Ohio Agricul. Expt. Stat., 1894, p. 125 (distribution), p. 133 (reference); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 66 (injuries in Ohio).

COOK: in Entomolog. Amer., i, 1886, p. 209 (ravages); Bull. 76 Mich. Agricul. Expt. Stat., 1891, p. 14 (reference).

BETHUNE: in 17th Ann. Rept. Entomolog. Soc. Ont., 1887, p. 59, figs. 33, 34 (brief mention); in 27th do. for 1896, 1897, pp. 55–56 (damage in Ontario).

BRUNER: in Insect Life, i, 1888, p. 66 (in S. Dak., Nebr. and Wyoming); in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, p. 98 (damage in Nebr., parasites); in Bull. 23 do., 1891, p. 14 (injuring beets); in Ann. Rept. Nebr. State Bd. Agricul., 1893, pp. 390–394, figs. 35–41 (brief general account); in Bull. 32 Divis. Entomol., U. S. Dept. Agricul., 1894, pp. 14–15 (injuries in Nebr. in '93).

FLETCHER: Ann. Rept. for 1887, 1888, pp. 11–12, figs. 1, 2 (life-history, ravages in Canada, remedies); in 19th Ann. Rept. Entomolog. Soc. Ont., 1889, p. 9 (brief mention); Ann. Rept. for 1894, 1895, pp. 192–194, figs. 2, 3 (life-history, ravages in '94 in Canada, remedies); in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 59–60 (injuries in Ontario); in Rept. Canad. Experimental Farms for 1896, 1897, pp. 231–234, figs. 3, 4 (general account of, in Canada).

HULST: Bull. xlvi N. J. Agricul. Expt. Stat., 1888, pp. 6–7 (remedies, brief); in Entomolog. Amer., v, 1889, p. 58 (contagious disease of army-worm).

BURNETT: in Insect Life, i, 1889, p. 287 (in Orleans Co., N. Y. in 1888).

DYAR: in Insect Life, i, 1889, p. 285 (moth attracted to electric light).

DANSBY: in Insect Life, i, 1889, p. 375 (injuries in Florida).

MILLER: in Insect Life, ii, 1889, pp. 76–77 (ravages in Indiana).

RILEY–HOWARD: in Insect Life, i, 1889, p. 356 (reference); in do., ii, 1889, p. 56 (ravages in Ind.), 1890, p. 258 (mention), p. 351 *Rhogas terminalis* Cr. reared); in do., iii, 1891, pp. 15, 17, 153, 154, 156, 157, 460 (reared parasites), p. 478 (mention); in do., iv, 1891, p. 157 (in the island of Jamaica); in do., vi, 1893, p. 41 (ravages in N. Mex. and Va.), 1894, p. 348 (mention), p. 374 (injuries reported in various localities); in do., vii, 1894, p. 269 (ravages in Va. from May to Sept.), p. 279 (abundance of moths at electric light).

TOWNSEND: in Insect Life, ii, 1889, p. 42 (destructive in Mich. in '81); in Psyche, vi, 1893, pp. 466, 467, 468 (flies bred from *Leucania unipuncta*).

ASHMEAD: in Insect Life, iii, 1890, pp. 53–57 (ravages in Md. in 1880).

HOWARD: in Insect Life, ii, 1890, p. 222 (irrigation for controlling); Circular 4 2d Ser., Divis. Entomol., U. S. Dept. Agricul., 1894, pp. 1–5, figs. 1–3 (brief general account); in Proc. Entomolog. Soc. Wash., iii, 1895, p. 225 (of distribution); Bull. 5 Technical Ser., Divis. Entomol., U. S. Dept. Agricul., 1897, pp. 33, 50 (mention), p. 51 (*Winthemia 4-pustulata* a common parasite).

OSBORN: in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, pp. 20–21 (mention); in Insect Life, v, 1892, p. 112 (mention); in Bull. 30 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 44 (injuries in Iowa in '92); in Bull. 33 Io. Agricul. Coll. Expt. Stat., 1896, pp. 600–603, figs. 3–5 (injuries in Iowa, brief general account); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 78 (injuries in Iowa).

HARRINGTON: in 21st Ann. Rept. Entomolog. Soc. Ont., 1891, p. 67 (*Ophion purgatum* a parasite).

KOEBELE: in Bull. 23 Divis. Entomol., U. S. Dept. Agricul., 1891, p. 44 (mention).

MOFFAT: in 21st Ann. Rept. Entomolog. Soc. Ont., 1891, pp. 51–54, figs. 21, 22 (ravages in Maritime Provinces and Eastern States); in 27th do. for 1896, 1897, pp. 77–78 (injuries in Ontario, etc.).

COCKERELL: Bull. 10 N. Mex. Agricul. Expt. Stat., 1893, pp. 10–14 (food-plants and remedies); in Insect Life, vii, 1894, p. 210 (mention).

GILLETTE: in Rept. Col. Agricul. Expt. Stat. for 1893, 1894, p. 53 (brief mention).

THOMPSON: in Insect Life, vi, 1893, p. 37 (in Tasmania).

GARMAN: in 5th Ann. Rept. Ky. Agr. Expt. Stat., 1894, pp. 56–59, fig. 8 (brief account as *Heliophila*); in 7th do. for 1894, 1895, p. xxxvii (very common in Ky., May 23, June 25–Sept. 1).

MURTFELDT: in Bull. 32 Divis. Entomol., U. S. Dept. Agricul., 1894, p. 37 (injuries in Mo. in 1893).

COMSTOCKS: Manual Study Insects, 1895, pp. 303–304, figs. 366, 367 (brief notice).

FORBUSH: in The Gypsy Moth, a Rept. of the Work Mass. Bd. Agricul., 1896, p. 33 (gypsy moth mistaken for army-worm), p. 121 (cyclone burner for army-worm).

LOUNSBURY: Bull. 28 Mass. Agricul. Expt. Stat. (Hatch), 1895, pp. 10–17, figs. 5–7 (cranberries injured, general account).

MCCARTHY: in Bull. 115 N. C. Agricul. Expt. Stat., 1895, pp. 164–165 (remedies, as *Heliophila*).

HOPKINS–RUMSEY: Bull. 44 W. Va. Agricul. Expt. Stat., 1896, pp. 261–262, 310, 312, 316 (brief description, remedies).

JOHNSON: in 9th Rept. Md. Agricul. Expt. Stat., 1896., p. 225 (ravages in Sept.).

KIRKLAND: in Bull. 3 Series of 1896, Mass. Crop Rept., July, 1896, pp. 28–37, figs. 1–6 (general account of in Mass.); Bull. 46 Hatch Expt. Stat. Mass. Agricul. Coll., 1897, p. 23 (toads eating army-worms).

LOWE: Bull. 104 N. Y. Agricul. Expt. Stat., 1896, pp. 121–129, figs. 1, 2, pls. I, II (general account and recent ravages).

LUGGER: 2d Ann. Rept. Entomol. State Expt. Stat., Univer. Minn., for 1896, pp. 14–20, figs. 8–10, pl. II, fig. 11 (recent injuries in Minn., general account); the same in Bull. 48 Minn. Agricul. Expt. Stat., 1896, pp. 42–48.

PERKINS: in 9th Rept. Vt. Agricul. Expt. Stat., 1896, pp. 134–142, figs. 20–25 (general account of, in Vermont).

TRUMAN: in Entomolog. News, vii, 1896, p. 299 (common in South Dakota).

WEED, C. M.: Bull. 39 N. H. Coll. Agricul. Expt. Stat., 1896, pp. 62–75, figs. 1–10 (general account of, in New Hampshire).

BROOKS: in 34th Rept. Mass. Agricul. Coll., 1897, pp. 82–84 (damage by, on college farm).

CHITTENDEN: Bull. 8 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1897, p. 42 (*Carcelia leucaniæ* a common parasite).

DEARNESS: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, p. 23 (injuries in Ontario).

FYLES: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 101–102 (brief mention).

PANTON: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 44–51, figs. 45–50, 1 map (general account of distribution and ravages in Ontario).

BRITTON: in 20th Rept. Conn. Agricul. Exp. St. for 1896, 1897, pp. 236–238, pl. 3, figs. *a–d* (in Conn., natural history, remedies).

SLINGERLAND: in Proc. 42nd Ann. Meet. West. N. Y. Horticul. Soc., 1897, pp. 23–24 (brief account of ravages in 1896 in New York); in Amer. Agricul., 59, for May 8, 1897, p. 582 (rarely injurious a second year); Bull. 133 Cornell Agricul. Expt. Stat., 1897, pp. 233–258, figs. 68–72 (extended account, in New York).

SOULE: in Psyche, viii, 1897, p. 11 (moths swarming in New Hampshire and at sea).

(The references above are additional to those given in the extended account of this insect by Prof. Riley in the 3rd Report of the U. S. Entomological Commission, 1883, pp. 146–156).

The notable entomological event of the year (1896) for the State of New York, has been the occurrence and severe ravages of the army-worm, *Leucania unipuncta*, over the greater part of the State. This insect is a quite common species, which is widely distributed over the country. When but moderately abundant it is but rarely, if ever, noticed by the farmer; occasionally, however, the caterpillars are so numerous and destructive as to create much alarm and lead to many wild surmises as to their origin.

Unprecedented Ravages in the State of New York.

The abundance of the caterpillars and the damage by them to the crops throughout the State is believed to be greater than had ever been observed before. Previous ravages of this insect in the State have been confined to limited portions, but the past year it has been destruc-

tive over by far its greater portion, ranging from its extreme east to the west and from the north to the south. The insect has been authentically reported from fifty-five of the sixty counties, but has probably been present, to a greater or less extent, in all. The following are known to have been infested to a greater or less extent:

Albany.	Essex.	Oneida.	Schuyler.
Allegany.	Franklin.	Onondaga.	Seneca.
Broome.	Fulton.	Ontario.	St. Lawrence.
Cattaraugus.	Genesee.	Orange.	Steuben.
Cayuga.	Greene.	Orleans.	Suffolk.
Chautauqua.	Herkimer.	Oswego.	Sullivan.
Chemung.	Jefferson.	Otsego.	Tioga.
Chenango.	Kings.	Putnam.	Tompkins.
Clinton.	Lewis.	Queens.	Ulster.
Columbia.	Livingston.	Rensselaer.	Washington.
Cortland.	Madison.	Rockland.	Wayne.
Delaware.	Monroe.	Saratoga.	Westchester.
Dutchess.	Montgomery.	Schenectady.	Wyoming.
Erie.	Niagara.	Schoharie.	

It has not been reported, so far as known, in the following counties: Hamilton, New York, Richmond, Warren and Yates.

From the nature of the attack, and from the reports at hand, it would be useless to estimate the damage caused by this insect to the farming interests of the State of New York the past year. The habit that the caterpillars have of feeding largely under cover of darkness, renders it quite safe to assume that in each of the fifty-five counties from which they have been reported, considerable injury to the crops has resulted. Besides the injuries reported, there are many individuals who have suffered considerable loss in silence. In addition to this, there is also the damage inflicted by the insect unknown even to the owners of the property involved. The two latter items would swell the total loss caused by this insect in the State the past year to a very formidable sum. The following newspaper items will give some idea of its abundance and destructiveness in the State of New York in its recent invasion:

In the vicinity of Easthampton [L. I.] the army-worm has appeared to the number of many thousands and has destroyed crops belonging to farmers, as well as fields and lawns of private residences.

The Journal, July 9.

The so-called army-worm was brought to my notice during the first week in July. It was then attacking the oat fields in northern Westchester and southern Putnam counties. It developed northward into Putnam county with great rapidity, and much alarm was felt, although it was hoped that many fields would escape and be cut later for the grain.

On July 12th all hope of saving the grain was abandoned and every oat field was hastily cut with scythe and mowing machine to save the straw for fodder. At this time many oat fields were utterly ruined on the southern border of the county, and those farther to the north were seriously injured in part. The oats in this section were unusually vigorous, the straw in many places measuring five feet in height, with leaves long, broad and succulent. The heads were heavy and well filled. In fact, the worms were well supplied with ample food and made a rapid development.

G. W. H. Brewster (Putnam county), N. Y.

The army-worm has destroyed a considerable portion of the crops in Dutchess and Orange counties within the past two weeks.

The Independent, New Paltz (Ulster county) July 24.

The much dreaded army-worm has invaded Columbia county and is working havoc with the crops in several towns. Over in Kline Kill the destructive pests have appeared in alarming numbers * * * *. They are also attacking growing vegetation on Abm. Vosburgh's land in Ghent. In Kinderhook the Scully farm is overrun with the worms which are spreading from field to field, devouring everything in their progress, except potatoes. Several other farms in the same town are also suffering from the pest

Chatham Republican (Columbia county), July 15.

Wherever the worm appears ruin follows its tracks, and many a farmer sees all prospect of abundant harvest fade away in a few hours. From the Plains come numerous accounts of their ravages, which are also reported on the South Side, where H. F. Slade had a fine piece of oats, covering eight acres, and last week estimated to yield 75 bushels to the acre. Sunday the worms were seen in the field for the first time. Monday their ravages had become so apparent, that it was decided to save the remainder of the crop by harvesting it at once. On Tuesday when it was cut with a reaper, the leaves had all been eaten off, and in many instances the head also, so that the field is nearly a total loss.

The Oneonta Herald (Otsego county), July 16.

In Chenango county the worms have confined their destructive work to the lowlands. Along the roads and fences, great swarms or droves of the pest may be seen making their way in one great wriggling, squirming mass from field to field. In Oxford the old fair grounds had been sown to oats and corn and also the pieces adjoining them. The worms migrated from one field to another, and in doing so, crawled over the building once used as a grand stand, that being used in place of a fence. The structure was one moving mass and attracted much attention from the village and surrounding country.

The Watertown Reformer (Jefferson county), July 18.

Anyone wishing to see the army-worm, should go to the Fairbanks farm on North Main street, near the Catholic cemetery, where the worms may be seen by the million in the oat fields. Every stalk and spear is literally covered with them. Mr. Fairbanks has as fine a piece of oats as is often seen in this section, but the terrible ravages of this pest will, in a few days, destroy the entire crop. The ground is so thickly covered with them, that it is impossible to step without treading on some.

The Jamestown Journal (Chautauqua county), July 10.

Farmers owning land on the west side of Black river, just east of Lowville [Lewis county], will have a new pest to contend with, and one that is making great havoc in pastures and meadows. The pest is a smooth, dark colored worm, about one and one-half inches long, resembling the army-worm. They made their appearance about a week ago, and as to numbers represent a vast army. They move in solid masses and devour everything in their track. Pastures that have been attacked are as barren of feed as a street pavement.

Oswego Times, July 10.

The army-worm has reached South Trenton [Oneida county], and is working sad havoc in the oat and corn fields. One prominent farmer who expected to raise about 400 bushels of oats said this week, after seeing the worms at work in his field, that he probably would not have a solitary oat. The worms appear very ravenous and have been known to eat grass that had matured and turned brown.

Utica Semi-Weekly Herald, July 17.

The army-worm which is working among farmers' crops in the eastern part of the State, is doing considerable damage at Walworth [Wayne county]. T. G. Yeomans & Sons, the leading farmers in the town of Walworth, seem to be troubled most with the worm, which began eating the grass in the pastures, whereupon the grass was set afire so as to get rid of them. Then the fodder corn was next tackled by the pest.

Rochester Democrat and Chronicle, July 22.

Earlville [Madison county], July 15. — The army-worms have reached this section and are doing their destructive work among the farmers by devouring their corn and oats in large quantities. This is the first time the worms ever appeared in this vicinity, and are thought to be passing by and steadily moving northward.

Rome Sentinel, July 17.

In the town of Bethlehem, Albany county, near the farm of Hon. John M. Bailey, they were seen by me on July 7th, completely eating up every hill of corn in their progress over a large field (Pl. II, also IV, fig. 2). A piece of timothy was badly eaten and rapidly being consumed by the host of hungry caterpillars — the heads bending down beneath their weight. They were found in millions in the field of rye in which they were first noticed, and as the rye was being cut, they were found in thousands underneath the sheaves. They were reportedon a farm just outside of Albany on Delaware avenue as eating everything before

them — oats, corn, and many vegetables, while they were so thick that one could not take a step without crushing many of them. So abundant were they that if a man stood still for a few minutes, they would crawl upon him in so great numbers that he could not easily divest himself of them. They were also very numerous just beyond the toll-gate on Western avenue where they had stripped all the leaves from a number of fields of fine looking oats, and leaving these, many had wandered on to the plank road where large numbers were crushed by passing vehicles.

The serious nature of the ravages of this insect was evidenced by the many telegrams and letters received concerning it, — the replies to which formed a considerable part of the correspondence of the Office for the month of July. In addition, numerous inquiries relating to the new depredator were sent to the Commissioner of Agriculture, to the Experiment Stations at Ithaca and at Geneva, and to the branch Station at Jamaica, Long Island.

In response to a telegram, the State Entomologist visited Governor Morton's farm at Ellerslie, and found that hordes of hungry worms were threatening the destruction of nearly 200 acres of his corn and oats. The condition of affairs was found to be exceedingly alarming, and it was only by the work of fifty men continued long into the night that the crops were in the main preserved. In a similar manner the army-worms were destroying the corn of George Canaday of Kinderhook, N. Y., at the rate of an acre a day. Mr. Canaday at once sent a special messenger with examples of the caterpillars to the office of the State Entomologist, to learn the proper methods of combating this enemy. The prompt action of this gentleman in accordance with the directions given him, enabled him to protect the greater portion of his fields.

Its Work in Other States.

The ravages of the army-worm during the year have also been marked in other States of the Union. Serious outbreaks occurred in Maine, and in the central and southern portions of New Hampshire and Vermont. In Massachusetts the cranberry crop in the three towns of Dennis, Harwich and Yarmouth on Cape Cod, was damaged to an estimated extent of $100,000. The injury to the grass and grain crops in the State, was estimated at fully $200,000, making a total loss by the army-worm of over $300,000. Serious ravages by this insect were also reported from Connecticut.

In New Jersey the insect was quite destructive in limited localities in different portions of the State. The damage in Pennsylvania appears to

have been severe and extensive over a large part of the State — Centre, Tioga, Bradford, Susquehanna, Chester, Dauphin, Perry, Bucks, Lancaster, York and Cumberland counties, being the most unfortunate in this respect. It was widespread in Ohio, although its injuries were local and could be hardly termed general. It was reported as quite injurious in Marinette, Menomenee and Monroe counties, in Wisconsin. In Minnesota its ravages extended over most of the State, and were represented as very severe. It was reported as more or less destructive in the following additional States: Missouri, California, Maryland and Iowa. In towns of the Province of Ontario, Canada, it was also quite injurious.

Earlier Losses in the State of New York.

The first authentic record of injury in this State by the army-worm, so far as we have found, was given by the Albany Argus in 1817. In this year many meadows and pastures in the northern towns of Rensselaer county, and in the eastern portions of Saratoga county were rendered "as barren as heath" by this insect. In 1842 some injury from it, was reported in the western part of the State. It committed severe ravages in the vicinity of Buffalo in 1861, also near the head of Seneca lake, and at several other points in the southern and western counties. In 1871 it was reported from Tioga county. Four years later it attracted attention the latter part of July, and in the middle of August it was quite abundant on Long Island. In 1880, it was again destructive in this State. The caterpillars appeared in June on Long Island, where they caused much alarm by their ravages. At this time they also occurred in some of the southern and eastern counties of the State.

It will be seen from the above that all the earlier appearances of this pest have been limited to comparatively small areas in the State, and, although the losses were considerable in some instances, especially in the visitation of 1880, it is believed that none approached in magnitude those of the present year.

Its Extended Distribution.

The army-worm has a remarkably extended distribution. Dr. Packard, in his map published in 1877, limited its range as follows: north, at latitude 48° in Minnesota, and at Cape Rozier in Quebec; east by the eastern portion of Nova Scotia; south, at the southern point of Texas; west, at parallel 102°. This range can now be considerably extended. It has been reported from Newfoundland, Prince Edward Island, and as widespread all over Canada. In the United States, in addition to the area given by Dr. Packard, the insect has been reported from South Dakota, Nebraska, Wyoming, Colorado, New Mexico; and the past

summer, "The Weekly Chronicle" reported ravages of the army-worm in July in the vicinity of Stockton, California. If the latter report can be regarded as authentic, it is safe to infer that the insect is, or may occur very soon, in every State in the Union.

Living specimens were also observed to issue from Mexican cereals exhibited at the World's Fair held at Chicago.

It has been recorded from the Island of Jamaica, and will probably be found in other islands of the West Indies. Other localities are: various parts of South America,—Venezuela, United States of Colombia, and Brazil; Isle of Wight; Lewes, South England; Maderia; Province of Nepaul, North India; Java; several places in Australia; New Zealand and Tasmania. *Leucania unipuncta* may well be deemed cosmopolitan, although only in the United States does its ravages attract much attention.

Description of the Insect.

Although the insect is a common one, and occurs in considerable numbers each year in the State of New York, yet from its seldom attracting particular attention, owing to its ordinary nocturnal habits, it appears to be known to very few persons other than entomologists. The following account of its features in its several stages may serve as a guide to its recognition.

The eggs.—They will rarely be seen by the ordinary farmer, but when met with, they may be recognized from the following characters: They are smooth, white when first laid, turning gradually to a pale straw color before hatching, about 0.023 inch in diameter, and usually deposited in masses glued together by an adhesive substance. They may be found between the leaf-sheath and the stem of grasses,—the toughest stalks in the thickest clumps being preferred for their place of deposit. They are also at times, laid on other herbage, on dead stems, sticks, and in other less favorable places when the moths are abundant.

The young caterpillars.—They are rarely seen and yet it is of great importance that the farmer should be able to recognize them before extensive depredations have proclaimed their true character. The recently hatched army-worms are about 0.07 of an inch (1.7 mm.) long and of a dull translucent white color. The head is brownish-black or yellowish with dark eyes. On both head and body there are minute scattering hairs. The young larvæ walk in a looping manner, as the two anterior pairs of abdominal legs are atrophied.

After the first molt the larvæ are about 0.2 of an inch (5 mm.) long. The head is a little darker in some cases and the striping seen in the full

grown caterpillars is becoming apparent. The general color of the body is yellowish-green with three, more or less well defined, rose-brown lines on each side of the body,—the lower line being the broadest and the most conspicuous. In this stage the minute black hairy tubercles of the body may be seen. The caterpillar still loops as it walks and spins a thread as it drops from a leaf when disturbed, as in the first stage. After the second molt the striping is more pronounced, though the general color is the same. The habit of looping when walking and of spinning a thread when it drops is lost: instead of the latter it curls itself up as it falls to the ground. After the third molt the caterpillars become a dull, dark green color and the head is mottled with dark brown. The striping is nearly that of the full-grown caterpillar. In the next two molts there is but little change in its markings and other features.

The full-grown caterpillar.—When full-grown or nearly full-grown, there is quite a range of coloring to be seen among a large number. Their general appearance is such that once seen they are easily recognized. The larger ones are about one inch and one-half (38 mm.) long, but associated with them are many smaller individuals, some of which are only about half the length of the largest. This range in size may be seen at the time when their ravages attract attention. They may be recognized in their latter stages by the median white line beginning at the head and extending a variable distance along the back — in some of the lighter and younger ones it may be traced the length of the body. On either side of the median white line, there is a broad brown stripe more or less distinct (in lighter individuals there may be a white mottling along this stripe), bordered laterally by a narrow one of darker brown. Next is a white line similar to the median one but more constant, and between it and the next white line there is a stripe of variable brown, sometimes mottled with white; it is usually lighter than the stripe on either side of the median white line. Next comes the stigmatal stripe which in well-marked individuals is the most striking, it being as dark as any, and below it is the white substigmatal stripe; these two are somewhat variable in color in different caterpillars. The ventral surface is a variable yellowish-green: the abdominal legs are brown at the base. The light and dark varieties of the caterpillars are represented in the two lower figures of Plate III.

The pupa.—The mahogany-brown pupa is about three-fourths of an inch (18 to 20 mm.) long. It is rather stout and on the anal extremity there is a pair of slightly converging spines, and on each side of these, two fine curled hooks. The spiracles are nearly black.

The imago.—The moth is a plain appearing reddish-gray or fawn colored insect with a spread of wing, averaging about one inch and one-half. The fore-wing has two large ill-defined spots of a slightly lighter color anterior to its center; behind the outer one, is the small characteristic white spot indistinctly bordered with black. There is a faintly indicated oblique line from the apex to near the outer third of the hind margin of the wing, of which only the portion of the line near the apex is continuous, the remainder being represented by dots. The tips of the veins are usually indicated by black, and the whole surface of the wing is slightly and variably specked with the same. The outer portions of the hind wing is a uniform dark gray; the basal portion lighter. Fringe with a grayish, silvery luster. Beneath, the wings are a silvery gray. The moth is shown in Plate III, figures *a*, *b* and *c*.

Life-history and Habits.

The life-history and habits of this, at times, very destructive insect are of the utmost importance in preventing its ravages or in checking it after the destructive work of the larvæ becomes apparent. Most, if not all, of its demonstrations are characterized by the sudden discovery of large numbers of caterpillars rapidly destroying the crops, and usually when thus discovered, it is too late to prevent serious loss. The number of broods in a year is controlled largely by the length of the season in connection with an abundance of suitable food. In the North there are but two or three generations in a year, while in the South, it is stated that as many as six may occur. The insect may pass the winter, in the northern portion of its range, either as moths or larvæ, and possibly in the pupal stage; in the southern portion, it may exceptionally hibernate in the egg.

The habits of the imago.—The moths may be seen on the wing in the early evening hours or during the day in cloudy weather. The flight is usually near the ground and is accompanied by a low humming sound, similar to, but less intense than that of the hawk-moths, it is strong, irregular, and plunging. They are probably capable of long-sustained flights, as on one occasion when they were swarming in houses in the vicinity of the Atlantic coast, fishermen reported a great cloud of the moths over their boat out at sea.

Their food is quite varied: they have been taken on the blossoms of apple-trees, on honeysuckle, soap-wort (*Saponaria officinalis*), and yucca. In August of the present year they were attracted in great numbers to the red berries of the Tartarian honeysuckle (*Lonicera Tartarica*), in Washington park, Albany, upon which they fed, either by puncturing

or abrading them, as many of the berries were more or less bruised, and but few other insects were seen around them. It is quite probable that they are drawn to the nectar of flowers and the juices of various fruits. They are also attracted by plant-lice, probably for the purpose of imbibing the honey-dew excreted by these insects. Mr. Van Duzee records an instance (*loc. cit.*) of the moths swarming around an apple-tree badly infested with *Aphis mali*. Dr. Smith, in his Report for 1896, p. 450, mentions their occurrence in large numbers among the plant-lice on melon-vines. The moths seem to require an unusual amount of food, the reason of which may be that the eggs are not developed in recently issued females: no traces of them were found in a number of females dissected during this year.

Oviposition is said not to begin until a week or more after the moth has emerged, and it is believed to continue for the remainder of the adult existence, which may amount to several weeks. No eggs were obtained the past season from females which were either reared from caterpillars or from pupæ collected in the field, although moths taken at the Tartarian honeysuckle berries oviposited within a few days. The eggs are ordinarily deposited by preference in thick tufts of grass, especially such as have been stimulated in growth by the droppings of cattle in pastures, and in other similar localities. The oldest and toughest stalks are selected, and on these the eggs are thrust down between the sheath and the stalk and usually secured in place by a gummy secretion. Early in the season the moth is known to deposit apparently by preference in cut straw of old stacks, in hay ricks, and even in old fodder stacks of corn stalks. Its eggs may also be found in bits of corn stalks on the surface of the ground, and in the preceding year's stalks of grasses; or, the moth may oviposit in the spring in young grain, and at times, on the leaves of plants upon which the larvæ rarely feed, as on clover. The eggs are most frequently deposited late in the afternoon and during the earlier hours of the night, in strings of fifteen to twenty ordinarily, although batches of nearly a hundred, in from three to eight rows on a single stalk have been found. In breeding cages the eggs have been placed in masses of over a hundred, arranged in several rows between two sticks. The first moth dissected by Dr. Riley was found to contain upwards of 200 eggs, but later dissections resulted in finding 562 and 737 eggs respectively, which is probably nearer the average number.

Habits of the larvæ.—The eggs hatch in from eight to ten days. The young larvæ remain in hiding most of the time, feeding only during cloudy weather and at night. They shelter themselves in the folds of leaves, in

stubble, and even under the bark of adjacent posts for the first few days, or they may simply rest at full length along a well-shaded leaf. Their habit of dropping upon the slightest disturbance, renders their detection more difficult. During their first week, they eat only of the lower epidermis of the leaf in a manner similar to young Crambid larvæ — at least such was the habit of those reared the past season. In about a week they begin to eat holes in the sides of the leaves, and thereafter their appetites develop rapidly. There is considerable difference in the growth of the larvæ even from the same mass of eggs and under almost identical conditions, some being nearly a molt in advance of the others. This same difference is the more marked in caterpillars growing under natural conditions in the field, where variation is the rule and not the exception. The abundance and the condition of the food has a great influence on the rapidity of their growth, for if abundant and succulent it will be most rapid, while if dry it will be much slower. The parent moth apparently seeks to give her offspring the best conditions when she searches out the thickest and greenest herbage in which to place her eggs, and in most cases it is in just such spots that the destructive armies have their origin. They are really centers of distribution, and should be so regarded.

Migrations.—The earlier stages of the army-worm escape observation in most instances, and it is only when they are unusually abundant and after they have become half-grown that they attract attention. It is not until then, and after all the food has been devoured in their immediate vicinity, that they are noticed. The caterpillars are now forced to move elsewhere or starve. In ordinary years this rarely occurs, for they are not sufficiently abundant to work any serious injury, unless it be a slight thinning of the crop. It will be seen, therefore, that the "marching" habit is abnormal, although it may be the one most familiar to many. The uniform movement of the caterpillars in the same direction may be explained as the most natural, because it is the easiest when they are abundant, for otherwise their opposing motions would be a hindrance to one another. The determination of the direction of the march is probably the result of chance to a great extent, and is governed largely by the direction taken by the first to move, although some are inclined to think that the insects march more frequently toward a certain point of the compass, and others believe that they scent a favorite crop in the distance. The food of the caterpillars is so abundant that it hardly seems necessary to suppose that they are guided to it by a special sense, and it is equally difficult to see how a knowledge of the points of the compass would aid materially in such a search.

In their marches the caterpillars move, so far as possible, in a nearly straight line, turning aside for nothing that can be surmounted. It has even been stated that they will climb the trunk of a tree to the lowest fork and descend on the other side. A number of instances have been reported in which they marched over buildings, where in some instances they were so thick as to cover the sides of the structure. They can not bear the hot sun, and so far as possible, avoid it in their travels, and after crossing a sunny field they may be seen resting in the shade of fences or shrubbery that may offer the desired relief. Water does not deter them. The rear ones push forward over the bridge formed by the dead and dying of the vanguard: if it be a large running stream they perish by the millions. Their march is not a very rapid one; it has been computed at, ordinarily, the rate of 30 yards an hour.

Occasionally it happens, that the army-worm will migrate from the fields for the sole purpose of finding a suitable place for pupation, as in instances when there is abundant food in a grain field, but the soil is too hard for the caterpillars to bury in easily. This was noticed to a limited extent in the outskirts of Albany, where after partly stripping the leaves in an oat field, the caterpillars in migrating, inflicted little damage to a corn and grass field adjacent, but later their pupæ were found in abundance under the leaves and grasses beside the outer fence — 35 being counted within an area of about two square feet.

Associates.—It is not an uncommon occurrence, that cut-worms are associated with the army-worm in its ravages. In the 11th Illinois Report, Mr. Coquillett records the presence of *Agrotis c-nigrum* in an army-worm attack, in the proportion of one cut-worm to eight or ten army-worms, while Dr. Howard found the proportion to be as high as one to five.* A single example of *Agrotis ypsilon*, was detected in a lot of over 100 army-worms received from Ghent, N. Y., early in October of the past year.

Food of the Caterpillars.

The favorite food of the army-worm is undoubtedly, the green succulent leaves of a luxuriant growth of some member of the true grass family, the *Gramineæ*. In fields of small grain, the greener leaves are quickly stripped from the stalk, and, if the stem is not too hard, the heads will frequently be eaten off and fall to the ground. Occasionally, the heads are partly eaten after they they have been lopped off, but more frequently they are left untouched by the caterpillars. This wanton habit of the army-worm, increases its harmfulness in grain fields, without any

*In *3rd Rept. U. S. Entomological Commission* 1883, p. 135.

commensurate gain to itself. Of the cultivated crops, wheat and oats appear to be the favorites. Corn is perhaps less frequently attacked, for the reason that its method of cultivation is such as to discourage the insect breeding in fields of it, while, as shown before, the attack of any field after marching has begun is determined largely by chance. Rye and barley are eaten, but apparently with less relish. When pressed by hunger, the army-worm can readily accommodate itself to circumstances and devour many plants differing widely in character from its chosen forage. The most important of these are: flax, clover, beans, peas, strawberry, leaves of fruit-trees, watermelon, cucumber, rag-weed (*Ambrosia artemisiæfolia*), cranberry, wild Solanum, capsicum pepper, Amarantus, asparagus, and onions. There are a number of other plants upon which the caterpillars have been successfully reared, and upon which they would probably feed in nature, if nothing else was convenient to them. Some of the food-plants mentioned above, have been reported as not eaten by the army-worm, while others report them as occasionally injured. It is probable that the caterpillars are guided largely by the demands of nature for sustenance, and in proportion to their necessity do they turn to whatever is at hand.

Pupation.

Many accounts of the army-worm record its sudden disappearance, "as if by magic." A field may be swarming with its hosts, and in a day or two none will be seen. But if one will examine the loose surface soil in a recently infested field or will look beneath the brush and dried grass on its borders, the mahogany-brown pupæ will readily be found. The caterpillars have simply entered the ground for pupation and will soon reappear as moths. The duration of the pupa state is governed largely by the temperature; in July of last year, it was about 20 days in this State, while in September it was lengthened to about 30.

Number of Generations.

In this State there were three broods the past season, which is probably the usual number. No observations were made on the first generation, therefore it is safe to assume that it was quite a limited one. It was the second that attracted attention throughout the State during the first two weeks of July. They completed their growth and pupated before the end of the month. The first of August moths were emerging, and by the 7th, no pupæ could be found in searching in what had been a badly infested field, although pupal shells were abundant. Numbers of moths were seen in Washington Park, in Albany, on August 14th and 17th, but a week thereafter they had all disappeared.

On September 26th, larvæ of the third brood were reported as committing serious ravages on the farm of Jacob Harder, Ghent, N. Y., where the second brood had been destructive in July.* A number of the larvæ were sent to my office, of which the last buried for pupation, about October 12th. Moths from these began to emerge the 27th, and continued to do so until November 21st. During this time, 77 moths made their appearance, coming out most abundantly from November 2nd to the 10th. The appearance of the adults so late in the season, renders it quite probable that they hibernate in the imago state in Albany, as has been observed at Cambridge, Mass., although a portion of the brood may also winter as pupæ. According to Dr. Howard, the insect may exceptionally pass the winter in the egg in some of the Southern States. It will be seen that these observations on the life-history of this insect agree quite closely with those of Prof. Weed, at Durham, New Hampshire; and other observations render it probable that there are ordinarily three broods each year in the other New England States, with the exception of northern Maine. In New Jersey, Dr. Smith reports three generations as the normal number in the northern portion of the State, while in the southern part a fourth is by no means unusual.

Summary of Life-history.

The life-history of the army-worm, so far as known in this State and the vicinity, may be briefly summarized as follows: Overwintered moths or recently emerged ones, which may have hibernated as larvæ, or possibly pupæ, deposit eggs early in the spring, and from them the first brood of larvæ develop. From their comparatively small number, they rarely prove very destructive and are consequently unnoticed. They mature, pupate, and the adults emerge and lay the eggs from which is produced the second brood. These in turn become nearly full-grown early in July, and we have the brood usually destructive, and the one which committed such widespread ravages in the State the present year. Pupation occurs in July and the moths emerge early in August. They deposit eggs the latter part of the month, and early in September the third brood makes its appearance, and by the latter part of the month they are full-grown. This is the brood which was quite destructive the present season, at Ghent, N. Y., pupating the last of September, or early in October,—the moths emerging the last of October and into November, and most probably passing the winter in the imago state.

*They were also reported as destructive on several farms in Berlin, Bolton, Northboro, and other places in Worcester county, Mass., during the last of the month.

Natural Agents Controlling the Army-worm.

The inquiries are frequently made: Where do the army-worms come from? Will they be abundant next year? The first question has already been answered, but the answer to the second may not be so readily given. The comparative abundance or scarcity of this insect, as well as of others, from year to year is controlled by natural causes. The most prominent of these are the relative abundance and quality of its food, the favorable or adverse climatic conditions, and the number and activity of its natural enemies. Temperature and moisture have an important bearing on the production of its food-plants, and all know that without an amply supply of proper food, the caterpillars would die while young or immature, and no serious injury to crops would result from their presence. Weather conditions have also marked effect upon insect growth and development. Cold and wet serve to impair lepidopterous life, and when such prevails while the insect is in its tender larval stages, great mortality is the result. Hibernation is a severe ordeal for many insects, and alternate freezings and thawings, to which they may be subjected, may terminate many insect lives. It is only when the climatic conditions in connection with other controlling causes are favorable to the rapid growth and multiplication of the insect, that the ravages of the army-worm reach the ruinous extent of the present year. Such combinations can not be predicted. They very rarely occur in consecutive years. The theory has been advanced, that a dry season followed by a wet one, is likely to be an army-worm year, and it is apparently borne out by records made. But the attempt to predict the abundance of the army-worm solely from the amount of rain-fall for the year, ignores the important part that the predaceous and parasitic enemies of this insect have in its control.

The army-worm is also subject to a deadly bacterial disease, which may be fatal to large numbers. In the western portion of the State, 25 per cent. were killed by it in some localities (Lowe, *loc cit.*, p. 128). Unfortunately, the disease is only effective, it is believed, under certain conditions, and these are rarely favorable in nature to any extended action, or even to artificial propagation.

Predaceous Enemies.

Fortunately for the farmer, the army-worm has a large number of foes that prey upon it. Swine are said to eat them greedily, and to prefer them to corn. Shrews, skunks, and weasels, are reported as consuming large numbers. Domestic fowls, especially ducks and geese, are valuable

allies in fighting an army of these caterpillars. Most, if not all, of the insectivorous birds feed readily on them. Some of the most serviceable are the bobolink, blackbird, robin, and meadow lark. The English sparrow should be credited with feeding on the army-worm to a certain extent. Others that have been observed are the king-bird, blue-jay, golden-winged woodpecker, phœbe, cow-bird, Baltimore oriole, chipping sparrow, chickadee, and quail. Frogs and toads devour them with a relish, the remains of as many as fifty-five having been found in the stomach of one garden toad.

A number of predaceous insects are known to prey on the caterpillars. The more common and perhaps the most important belong to the family of *Carabidæ*, or ground-beetles, which may be found under stones and other shelters in the fields. One of the most efficient of these in this State, is the fiery ground-beetle, *Calosoma calidum* (Fabr.). This fine beetle may be easily recognized by the six rows of large coppery-red, or golden spots on the wing-covers. Both the beetle and its larva, are fierce enemies of the ordinary cut-worms, as well as army-worms. In the Southern States, the allied *Calosoma scrutator* (Fabr.), with its bright green wing-covers margined with a resplendent coppery-red, is an equally deadly enemy of the army-worm. Two other species of this genus, *C. externum* (Say) and *C. Wilcoxi* Lec., have also been observed preying on the caterpillars. A common tiger-beetle in this State, *Cicindela repanda* Dej., is another of its deadly foes. Besides these, the following ground-beetles have been observed preying on the caterpillars: *Elaphrus ruscarius* Say, *Pasimachus elongatus* Lec., *Pterostichus sculptus* Lec., *Amara angustata* Say, *Platynus sinuatus* (Dej.), *Cratacanthus dubius* (Beauv.), *Harpalus caliginosus* (Fabr.), *H. Pennsylvanicus* (DeGeer), *Selenophorus pedicularius* (Dej.,) and *Anisodactylus rusticus* (Say). A large southern bug, *Metapodius femoratus* (Fabr.), has been observed in large numbers sucking the juices from the army-worms. This rapacious insect, it is said, has the peculiar habit of hanging the caterpillar skins after it has sucked them dry, in the crotches of May-weed in the infested field.

The large ground spiders are said to prey freely on the army-worms, and the spinning forms often entrap the moths in their webs for their food.

Parasites.

The army-worm is subject to the attacks of a large number of true parasites, several of which are very destructive to the caterpillars, and may be classed with natural enemies, having an important part in keeping the insect from becoming excessively abundant. The most important of these

are the red-tailed Tachina-fly, *Winthemia 4-pustulata* (Fabr.), formerly known as *Nemorea leucaniæ* (Kirk.), but which has recently been found identical with this European species; and the yellow-tailed Tachina-fly, which was described as *Exorista flavicauda* by Riley, but it has recently been pronounced identical with *Belvoisia unifasciata* Desv., by Mr. Coquillett. These two flies are frequently seen in numbers in fields where the army-worm is numerous. They are often so abundant that their buzzing reminds one of a swarm of bees. Their conspicuous white eggs are usually deposited on the head or thoracic segments of the caterpillar, where they can not be reached by the jaws of the victim for their removal; occasionally they may be found on the anterior abdominal segments. As many as eighteen eggs have been counted on a single caterpillar, but the average is about five. The eggs soon hatch and the young maggots make their way into the body of their host, where they revel in its juices and eventually cause its death. This Tachina oviposition is not, however, necessarily fatal to the larvæ, for if it occurs at near the molting, the eggs may be cast with the skin before the time for their hatching. The proportion of caterpillars parasitized in the vicinity of Albany, was observed to be quite small, probably about 8 per cent., but in the central and western portions of the State, the eggs of these parasites were comparatively abundant.

The following flies have been reared from the army-worm: *Cistogaster immaculata* Meq., *Ocyptera cuchenor* Wlk., *Miltogramma argentifrons* Twns., *Myophasia ænea* Wied., *Sarcophaga helicis* Twns., *Sarcophaga œdipodinis* Twns., *Sarcophaga* (two species), *Lucilia cæsar* (Linn.). It is more than probable that some of these are not true parasites.

Next in importance perhaps to the Tachina flies as parasites, are the minute four-winged Microgasters, several species of which are parasitic on the army-worm. The most abundant of these is the military Microgaster, *Apanteles militaris* (Walsh), which is usually present, wherever the army-worm abounds. From sixty-two to ninety-six of its larvæ have been found in the body of one caterpillar. Its whitish cocoons are often attached to the grass, or to the under side of sticks, stones, etc., in small masses surrounded by more or less loose silk. *Apanteles limenitidis* (Riley) is another species parasitic on the army-worm. Unfortunately, these two beneficial insects are in turn parasitized by a Chalcid, *Glyphe viridascens* Walsh, and by a small Ichneumonid, *Mesochorus vitreus* Walsh. *Haltichella perpulchra* (Walsh), is also a parasite of one of the Microgasters above-named. Another smaller parasite of the army-worm is the wingless *Pezomachus minimus* Walsh, which in turn has its Chalcid

parasite, *Smicra albifrons* (Walsh). *Ophion purgatum* Say, is one of its larger parasites, and in some localities it is often quite abundant. In Minnesota its cocoons were numerous in the infested fields the past year. The following species are also recorded among its parasites: *Ichneumon leucanie* Fitch and *I. flavizonatus* Cress., *Hemiteles laticinctus* Riley MS., *Stibeutes gentilis* Cress., *Limneria oxylus* Cress., *Mesochorus scitulus* Cress., and *Rhogas terminalis* Cress. *Bassus scutellaris* Cress. was observed apparently ovipositing on the army-worm.

Preventives and Remedies.

When a field has become badly infested with half-grown army-worms, little can be done to save the crop beyond cutting at once what remains and promptly removing it from the field. In order to prevent injuries by this insect, the intelligent farmer will, so far as possible, combat it along two lines. In the first place he will endeavor to prevent it breeding in numbers in his fields by so cultivating and caring for his crops as to offer the least favorable conditions for hibernation, oviposition, and the subsequent growth and development of the caterpillars. Secondly he will make effort to protect and favor its natural enemies.

Destruction of hibernating forms.—Whether the insect passes the winter as a moth or a caterpillar is not so very important to the farmer, provided he can destroy them in either state. In nature both the moths and caterpillars shelter themselves largely under thick grass and rubbish as winter approaches. The burning over of such places late in the autumn or preferably in the early spring must result in the destruction of large numbers of the insects. This measure would at the same time kill many other injurious insects hibernating in such places, and also, unfortunately, some beneficial forms. It is believed, however, that the benefit resulting from the burning would far outweigh the loss caused by the destruction of our insect friends.

Proper cultivation.—It has been shown in the preceding pages that the moth exhibits a decided preference for thick herbage of some kind when about to deposit her eggs, and that such areas are distributing centers to other portions of the infested fields. Many such places are to be found in the neglected weeds and grasses springing up beside fences, or they may occur in the middle of fields, as the result of unequal manuring. The good farmer by keeping his entire fields clean, and avoiding uneven manuring, will not offer conditions that invite oviposition.

Encouraging natural enemies.— Among the most beneficial may be counted many of our insectivorous birds. They have repeatedly been observed feeding on the army-worms in badly infested fields. If the grain fields are not sown too thickly, not only is a better crop secured, but the birds, having more wing room in the grain, will feed to a much larger extent on the caterpillars. Unfortunately, little can be done toward encouraging the insect enemies of the army-worm beyond protecting them so far as possible, and giving them the favorable conditions that may attract them.

Watching for indications.— The measures given above are not to be depended upon entirely, even though carried out to the letter. They should be supplemented by watchfulness. If the army-worm commences its operations in a field in unusual abundance, it is of the utmost importance that its presence should be known at once. The discovery is usually made, and advice sought in the matter, when it is too late to save more than a scanty half or less of the crop attacked. It is not a difficult task to discover the caterpillars some days before they are usually seen, and no man should begrudge the time devoted to the search. The thickest portion of a field should be examined for their small black or brown droppings, and the condition of the lower leaves of the grass or grain noticed. If the leaves are injured or absent, something has been eating them. The enemy may be found hidden under loose shelter of any kind on the ground or just below the surface, or when very small, upon the plants. If they are discovered before serious injury has been done to the crop, it is comparatively easy to decide whether or not to cut it at once. If the field is thickly infested, they will destroy the crop unless it is taken from them.

The commencement of an army-worm attack, as above noted, will rarely be detected. It is only when their operations can no longer be hidden from ordinary observation that alarm is excited, and the necessity of active measures for arresting their destructive marches from field to field becomes apparent. Some of the following measures will then be found of service :

Lime, dust, etc.— If the army-worms are numerous in a field—at an early stage in their operations, it would probably be wise to cut the crop at once and save what is left of it, although air-slaked lime, land plaster, or even road dust freely distributed over the vegetation when it is wet with dew or rain, would render it unpalatable to the caterpillars and compel them to seek other food.

Poisoned bran mash.—This was used in different localities in the State the present year with considerable success in infested fields. It was reported in several instances that the caterpillars would even leave the corn upon which they were feeding and descend to the ground for the purpose of eating the attractive bait. Large numbers were killed by its use and the crops were protected to a considerable extent. The recipe for its preparation is as follows: 35 lbs. wheat bran, 1 gallon of molasses and 1 lb. Paris green mixed to a proper consistency with hot water. It should be distributed just before nightfall, as then the caterpillars are usually beginning their feeding.

Ditching.—This method is of value only in keeping the army-worms out of fields comparatively free from them, and it is quite effective if properly conducted. The ditch may be made by plowing a rather deep furrow with its perpendicular side towards the field to be protected. At intervals in the ditch of fifteen or twenty feet, holes of about two feet in depth should be made (easily done with a post-hole auger) into which the caterpillars, unable to climb the wall, will fall and die. As often as the holes become filled they may be easily killed and removed. The furrow or ditch should have the perpendicular side clear of all weeds, roots, and other matter that might aid in climbing out. An improvement on the single furrow has been recommended by a resident of Dutchess county. The first furrow is turned towards the crop to be protected, and then returning with the plow in the furrow, the perpendicular wall is made next to the crop. By this means soft crumbly earth is obtained on both sides of the furrow, which will be more difficult for a caterpillar to climb than a smooth firm surface. If the one ditch should by any means prove insufficient, a second, a short distance in advance of the other, could be made.

Bands of tar.— Broad bands of tar have been used in some of the Western states in lieu of ditches, but, as they require to be renewed as often as they become bridged or the tar hardened, this method would doubtless be more expensive than the ditching. Another method is the tarring of boards and setting them up on edge as barriers. This is more effectual than bands of tar, but it is more expensive.

Poisoned strips.—A field may often be protected by spraying an exposed strip heavily with Paris green and water, or by sprinkling it with land plaster and Paris green. In either case it should be heavily poisoned. The poisoned portion of the crop should be carefully destroyed after it has served its purpose, in order to prevent the chance of its being eaten by stock.

Spraying with kerosene.—A safer way and just as effectual as poisoning strips with Paris green, would be found in spraying a strip with kerosene or a strong kerosene emulsion; but repeated applications — as many possibly as six in a day might be required to keep the traveling army in check.

Dragging the rope.— This method has been recommended in former years, but its efficacy may be questioned. It is simply drawing a long rope, held by a man at each end, over the infested field. The grass or grain bows under the weight of the rope and, as it springs back, the caterpillars drop to the ground where they remain for some time. It would need frequent repetition and would prove effective only when the field is not badly infested.

As means of protection from the ravages of this destructive pest, a number of methods have been named from which selection may be made of those which seem the most practicable for use in the localities or fields invaded. It not infrequently occurs that a remedy for some insect depredation which fully accomplishes its purpose under certain soil and other conditions, will in places where the conditions are of a markedly different character, prove to be of no value whatever.

Steganoptycha Claypoliana (Riley).

A New Maple-Tree Insect.

(Ord. LEPIDOPTERA: Fam. TORTRICIDÆ.)

RILEY: in Amer. Nat., xv, 1881, pp. 1009–1010 (compared to *Proteoteras esculana*); in id., xvi, 1882, pp. 913–914 (the name of *Proteoteras Claypoliana* proposed); the same in Scien. Amer., Suppl., No. 363, Dec. 16, 1882, p. 5797; in Amer. Nat., xvii, 1883, p. 978 (compared with *Proteoteras esculana*, and referred to *Steganoptycha*); reprint of same in Papilio, iii, 1883, p. 191.

CLAYPOLE: in Proc. Amer. Assoc. Adv. Sci. for 1881, 1882, pp, 269–270 (abstract of life-history; erroneously referred to *Sericoris instrutana*); in Psyche, iii, 1882, pp. 364–367 (notes on life-history).

SMITH: List Lepidopt. Bor. Amer., 1891, p. 93, No. 4976.

LINTNER: in Country Gentleman, lx, 1895, pp. 484–485 (recorded on maple, life-history); 11th Rept. Ins. N. Y., 1896, pp. 278, 285 (abstract of preceding, mention).

The interesting insect named above is very unobtrusive in its habits, if one may judge from the few notices that have appeared of it. There is no record of its having been observed in the field by more than

four different individuals. Although it appears never to have been so abundant as to cause much damage, yet it is most probable that careful observation would reveal its presence in many hitherto unsuspected localities.

Burrowing in the Petioles of Maple Leaves.

The following communication from a correspondent of the *Country Gentleman*, gives a brief account of the operations of this insect when for the first time detected upon the maple (in 1895), so far as any record is to be found:

I enclose leaves of sugar maple, the petioles of which are infested with a minute larva. My attention was first attracted by numerous green and half withered leaves lying on the ground with only a short portion of the petiole attached, which led me to look for the remaining portion; this I found attached to the tree, with a small channel extending towards its base. At the end of this was the larva. About a year ago I passed some rows of sugar maples appearing as mine do now, and I attributed the cause to a fungoid blight, but without examination. W. T.
Concordville, Pa.

When fallen maple leaves have been noticed during the early part of the year, it has usually been ascribed either to frost or some fungus attack. But in this instance, the leaves affected in the manner stated happening to come under the eye of a close observer, the cause was looked for, and careful search disclosed it in a small caterpillar burrowing within the portion of the leaf-stalk remaining upon the tree.*

From the examples of the leaves and separate portions of the stems or petioles sent, the operations of the caterpillars have been followed and its species determined. It proves to be the larva of a small Tortricid moth which has received the name of *Steganoptycha Claypoliana* — after Prof. Claypole, who had studied and made first publication of the insect when working in the leaf-stalk of the horse-chestnut, in Ohio.

Confused with a Closely Allied Insect.

This species was confused at first with a closely allied form, *Proteoteras æsculana* Riley, reared from larvæ found boring the leaf-stalks and the tender terminal twigs of the buckeye and maple in Missouri, and was referred to this form. A little later, it was regarded and described by Prof. Riley as a distinct species of the genus. Finally it was referred to *Steganoptycha* by Prof. Fernald.

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* Mr. Zabriskie has placed on record an injury to the petioles of maples at Flatbush, L. I., which is most probably the work of this insect (see *Journ. N. Y. Entomolog. Soc.* iii, 1895, p. 144).

It may be distinguished from *P. æsculana* by the following characters, according to its describer:

Claypoliana lacks the notch in posterior borders of primaries, the tufts of raised scales on the discs of same, and the peculiar tuft or pencil of hairs on the upper surface of secondaries in the male, between the margin and the costal vein. It is a shorter, broader-winged species; the ocellate spot is less distinctly relieved, the median oblique band more broken, the basal-costal portion paler and contrasted along the median vein with a dark shade which may be almost black, and which broadens posteriorly till near the middle of wing, where it is abruptly relieved by a pale space obliquing basally.

Description of Several Stages.

The moth has been characterized briefly by Prof. Claypole as follows: "It was small, with a peculiar hopping flight, the fore wing mottled black and white, and the hind wing more uniform in color, dusky, and slightly spotted with black near the tip."

The light red pupa was inclosed in a rolled up leaf lined inside with silk. Eight abdominal segments were visible.

A larva examined May 13th was two-fifths of an inch long with a yellow head and yellowish body. The minute granulations of the skin are smooth,—not pointed as in *P. æsculana*. The same general appearance was retained until pupation, except that it became a little darker.

Operations and Life-History.

In the leaf-stalks of the buckeye, *Æsculus glabra*, Prof. Claypole found the insect during the early part of May. About the 10th, they deserted the petioles through the holes by which they had entered, and betook themselves to the fading leaves. Upon the dying foliage they completed their growth naturally to all appearances. This food-habit is apparently normal, as no nibbled green leaves were found on the infested trees after the larvæ had deserted the leaf-stalks. Pupation occurs the latter part of May,—the first pupa being found on the 25th. The moth appears about fifteen days later. Prof. Claypole was not able to ascertain the place and manner of the deposit of its eggs, the number of broods, or the form in which it hibernates.

The work of this insect in the maple leaves coincides closely with that in the buckeye. The egg of the parent moth appears to be placed at the base of the leaf,—perhaps at the divarication of the ribs. As the young larva tunnels the petiole, the portion traversed by it shrivels, blackens, dries, and is broken off by the weight of the leaf. The larva con-

tinues its course downward, and on the stalks examined could usually be found at the end of a freshly cut channel of about one-half inch in length. In several instances a small opening was visible in the petiole through which the larva had emerged to undergo its transformations within a fold of a shriveling leaf, or possibly among the leaves on the ground.

Its Habits Compared with Those of Proteoteras æsculana.

These closely allied insects have different habits that are of value in distinguishing the species. *S. Claypoliana* bores the leaf-stalk of both the buckeye and maple and very rarely the twigs of the former. It is also known to feed on the blossoms of the buckeye. The larva of *P. æsculana* bores the slender terminal twigs of both these trees and often forms a swelling or pseudo-gall—the former insect never produces a gall. *P. æsculana* bores the petioles and terminal twigs for a distance of from one-half an inch to two inches, and lives in the gall, apparently through most of its larval existence. It feeds also on the winged seeds of the maple. *S. Claypoliana,* on the contrary, seldom or never bores along the leaf-stem more than half an inch, very rarely enters the terminal twigs, and lives in the rolled up leaf after the first two or three days.

Remedies.

The mining within the leaf-stalk by this insect has caused many leaves of the buckeye and maple to fall in certain localities, yet it is not probable that it will multiply and spread to such an extent as to become a serious pest, although in one of the maple twigs sent, four of the five leaves that it bore contained larvæ within the petioles.

Should further observations show that many of the fallen leaves carry with them to the ground the infested portion of the petiole or the insect within the folds of the leaf, as they appear to do in some instances, then it would be of service to collect and burn the leaves as soon as they fall, and before the larva has left them.

Oxyptilus periscelidactylus (Fitch).

The Gartered Plume-Moth.

(Ord. LEPIDOPTERA: Fam. PTEROPHORIDÆ.)

FITCH: in Trans. N. Y. State Agricul. Soc. for 1854, 1855, pp. 843–847 (larva, pupa, imago, described, habits; as *Pterophorus*); the same in 1st–2d Rept. Ins. N. Y., 1856, pp. 139–143.

PACKARD: Guide Study Ins., 1869, pp. 356–357, Pl. 8, figs, 23, 23*a*, 23*b* (brief account, as *Pterophorus*); Entomol. for Beginn., 1888, p. 150, fig. 179 (as *Pterophorus*).

RILEY: 1st Ann. Rept. Ins. Mo., 1869, pp. 137–138, Pl. II, figs. 15, 16 (common in Mo., description; as *Pterophorus*); in Amer. Entomol.–Bot. ii, 1870, pp. 234–235, fig. 148 (injuries, life-history; as *Pterophorus*); the same in 3d Ann. Rept. Ins. Mo., 1871, pp. 65–68, fig. 27; Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 32 (reference).

SAUNDERS: in 1st Ann. Rept. Entomolog. Soc. Ont., 1871, pp. 102–103, fig. 42 (life-history, habits; as *Pterophorus*); the same in Rept. Fruit Growers' Assoc. of Ont. for 1870, 1871; in 2d Ann. Rept. Entomolog. Soc. Ont., 1872, p. 18, fig. 11 (troublesome in Ontario, as *Pterophorus*); in Canad. Entomol., v, 1873, pp. 99–100, fig. 15 (description, life-history; as *Pterophorus*); Ins. Inj. Fruits, 1883, 1889, pp. 268–270, fig. 278 (general account).

PERKINS: in 5th Rept. Vt. Bd. Agricul., 1878, pp. 274–275, fig. 22 (brief account, as *Pterophorus*).

FRENCH: in 7th Rept. Ins. Ill., 1878, p. 268 (brief notice, as *Pterophorus*).

DIMMOCK: in Psyche, iii, 1882, p. 390 (liability to parasitism), p. 403 (bibliography).

KELLICOTT: in Bull. Buff. Soc. Nat. Sci., Jan., 1882, separate, p. 1 (mention).

COOKE: Inj. Ins. Orch.-Vin., 1883, pp. 191–192, fig. 177 (brief account, as *Pterophorus*).

FERNALD: in Kingsley's Stand. Nat. Hist., ii, Crust. and Ins., 1884, p. 437 (brief account); Bull. 12 Hatch Expt. Stat. Mass. Agricul. Coll., 1891, p. 32, fig. 26 (brief account).

SMITH: in 10th Ann. Rept. N. J. State Agricul. Expt. Stat. for 1889, 1890, pp. 288–290, fig. 16 (brief account of, in N. J.); Cat. Ins. N. J., 1890, p. 359 (common); List. Lepidopt. Bor. Amer., 1891, p. 88, no. 4594; Econom. Entomol., 1896, pp. 318–319, fig. 366 (brief account).

LINTNER: in Country Gent., lvi, 1891, p. 497 (general notice); 8th Rept. Ins. N. Y., 1893, p. 284 (abstract of preceding), p. 297 (reference); 10th do., 1895, p. 516 (reference).

RILEY–HOWARD: in Insect Life, iii, 1891, pp. 469–470 (brief mention as *Pterophorus*, one annual brood).

BRUNER: in Rept. Nebr. State Hort. Soc. for 1895, pp. 72, 147–148, fig. 77 (brief account, after Saunders).

COMSTOCKS: Man. Study Insects, 1895, p. 238, fig. 284 (brief account).

DYAR: in Psyche, vii, 1895, p. 253, fig. 4 (larval tubercles, setæ).

Among the many insects that prey upon the grapevine, this, in the winged form, notwithstanding its small size, is one of the prettiest and most peculiarly formed of the many species that have the vine for their food-plant. It is not ordinarily very destructive, although widely distributed and more or less injurious from year to year. The present season, however, State Botanist Peck, found it in unusual abundance in his garden at Menands, N. Y., necessitating his going over the vines and destroying the larvæ in the young tips (by pinching with the thumb and forefinger), six times during the season, whereas in former years, only two inspections were needed to keep them under control.

This species was unusually destructive in Westchester county, N. Y., in 1891, as appears from the following letter to the *Country Gentleman* :

I inclose bud and leaf of grapevine, in which you will find a small white hairy worm, which in its first stage appears to be black or brownish, and has the habit of spinning a web and gluing the budding leaves together. It is a voracious feeder, and soon destroys the leaves of the vines and young grapes. To-day, I sprayed the vines with whale oil soap suds, and if this is not effective in destroying the pests, I will try Paris green. Perhaps, Dr. Lintner can give the name, and suggest some good way to destroy this enemy of the grape. D. J. G.

The insect was readily identified as the gartered plume-moth, *Oxyptilus periscelidactylus* (Fitch), and reply was made giving its general family characters, habits, and distribution, together with the best remedies.

Characters of the Family.

This moth and its closely related species, comprising the small family of *Pterophoridæ*, are easily distinguished from all others, by their wings being split into two or more long narrow lobes. From this peculiar wing-structure, Latreille, many years ago, termed them *Fissipennes*, or Split-wings. The borders of the wings are densely ciliated, the hind margin of the fore-wings, and the fore and hind margins of the lobes of the two pairs of wings have very long ciliæ. The long slender legs are provided with stout spines at the apex of the tibiæ, a single one on the fore tibia, a pair at the apex of the remaining, and the hind tibiæ with an additional pair of spines midway of their length.

Description of the Moth.

"The moth, which is shown in figures 8, 9, Pl. V, is an elegant little insect, its wings measuring, when expanded, about seven-tenths of an inch across. The fore wings are long and narrow, and cleft down the middle about half-way to their base, the posterior half of the wing having a

notch in the outer margin. Their color is a yellowish brown, with a metallic lustre, and several dull-whitish streaks and spots. The hind wings are similar in color to the anterior pair, and are divided into three lobes; the lower division is complete, extending to the base, the upper one not more than two-thirds of the distance. The outer and hind margins of the wings, as well as all the edges of their lobes, are bordered with a deep whitish fringe, sprinkled here and there with brown; the body is long and slender, and a little darker than the wings. The antennæ are moderately long and thread-like, nearly black, but beautifully dotted with white throughout their whole length. The legs are long, banded alternately with yellowish brown and white, the hind ones ornamented with two pairs of diverging spines, having at their base a garter-like tuft of long brown scales, from which feature the moth derives its name." (Saunders.)

The Pupa.

The greenish or yellowish pupa of this insect has a very peculiar form. It may be found hanging from the leaves or bark of the grape, as an irregular, ragged looking object with an inclination to the supporting surface of about 40°. The head is obliquely truncate, from which the body tapers, slightly curving dorsally to the tip (fig. 5, Pl, IV). It is ridged, angulated, and with numerous projections—the most prominent of which is the dorsal, located about midway of its length. Dr. Fitch has compared it to the dead fragments of a little scraggy twig. The pupæ vary considerably in color, being either green or some shade of brown. It is said that the green ones are found only on the green leaves and the brown on the brown bark of the twigs; in each case they harmonize so perfectly with their surroundings that it is not easy to detect them; and such was found to be the rule among a large number reared recently. The changing of the numerous larvæ to this state under such protective conditions, has frequently led to the statement that the insect had suddenly disappeared. The duration of the pupa state is usually six or eight days, but it may be prolonged to fourteen by cold or other unfavorable conditions.

The Larva.

In the early spring as the leaves of the grape begin to unfold, here and there some of them may be seen webbed together. Within these clusters of developing leaves, represented in figure 3, Pl. IV, the greenish white-haired larvæ of this insect may be found. As an aid in identification, its description by Dr. Fitch is herewith transcribed.

The larva when full grown measures about half an inch in length. It is almost cylindrical, sixteen-footed, of a very pale green color, divided into fourteen segments by rather deep wide transverse constrictions. It has two rows of elevated white spots along the back, and one along each side, each segment having one spot in each row, or four spots in all, and between the spots is a smaller white elevated dot, and another similar dot below the lower spots. From each of these elevated spots and dots white bristles of different lengths stand out in all directions. (Pl. IV, fig. 4.)

Life-history of the Insect.

There seems to be very little definite knowledge of the life-history of this insect. The larvæ may be found soon after the leaves begin to appear, and complete their growth during the last of May or early in June. Prof. Riley gives the duration of the larval existence as about three weeks. Several larvæ received from Prof. Peck the past season pupated May 25th and others June 1st. The moths emerge about the middle of June. From this time until the appearance of the caterpillars on the vines the following spring, nothing definite seems to be known of the life-history of this insect. There is but a single brood in a season, according to Dr. Fernald. Mr. Saunders is of the same opinion and he suggests that it may pass the winter in eggs deposited on the canes of the vines near the base of the bud from which the next year's branch is developed. Prof. Riley, reasoning from analogy, suggests that the insect has two annual broods and that the second hibernates in the adult form. According to Furneaux,* the late feeding Pterophori emerge in the autumn and hibernate as moths, but of the hibernation of the earlier appearing ones no hint is given. It is in the imago state that the second brood of the English *Agdistis bennetii* passes the winter (see Fernald *loc. cit.*). No one has reported examples of a second brood of *O. periscelidactylus*, although several careful observers have looked for them. The moths of the single-brooded *Alucita hexadactyla* emerge in England during August, and remain on the wing until October, and then hibernate. After making due allowance for the difference in climate between this country and England, it seems reasonable to suggest that our gartered plume may fly through July into August under normal conditions, and then pass into hibernation, or, as suggested by Mr. Saunders, it may winter in the egg state. There appears to be little ground for supposing the insect to be double-brooded.

Of a large number of the moths which were reared during the latter half of June—a few days after they had emerged, several were observed

*Butterflies and Moths (British), 1894, p. 294.

in coition. No eggs were apparently deposited by them, and in the course of about ten days the adults were all dead. As they had no proper food, this probably hastened their death and might also account for the non-production of eggs.

Earlier History and Nature of its Injuries.

The operations of the insect first came under the notice of Dr. Fitch in 1854, and at that time it seemed to him more destructive than any other grapevine feeding species whose life-history had hitherto been given. It was reported in 1869 as very common in Missouri by Prof. Riley, and the following year it was more injurious than usual in that section. The same year it was very troublesome in Canada, according to Mr. Saunders.

The principal injury by this insect is the destruction of the unfolding leaves in the early spring, and if unmolested the young larvæ will later devour the forming blossoms.

Distribution.

The gartered plume has a wide distribution throughout Canada, the Eastern United States, and westward at least as far as Missouri. It is also known to occur in Nebraska, and California, and it will probably be found in all of the Northern and Middle States of the Union.

Parasites.

Several parasites have been reared from this insect by Dr. George Dimmock, who simply records the fact without giving the names. None were obtained by me the past season, and there is no record at hand of rearings by others. From this, it may be inferred, that the parasites of this insect are not abundant.

Remedies.

The presence of the larvæ, is readily indicated by the webbing together of the terminal leaves. The caterpillars are so sheltered within the inclosing leaves, that arsenical spraying would be of little value against them. The most practicable method of keeping the insect in check, appears to be the simple one of going over the vines a few times in the early spring and crushing the concealed caterpillars by hand within their nests, which are easily detected.

Additional Notes on Sciara.*

The Fungus Gnats.

(Ord. DIPTERA: Fam. MYCETOPHILIDÆ.)

A number of species of this genus were noticed in the *Tenth Report on the Injurious and Other Insects of the State of New York*, and two, believed to be new to science, were described. During the present year several other forms were received from Dr. J. B. Smith, of the New Jersey Agricultural Experiment Station, who had bred them from mushrooms, decaying potatoes, and decaying blackberry roots. On his request they have been given some study. The species of *Sciara* are so similar to one another in many respects, that it is difficult to recognize the various species from some of the descriptions published. Those bred from the mushrooms and potatoes, however, do not agree with any descriptions accessible to me, of either European or American species of this genus, and they are herewith described as new:

SCIARA MULTISETA n. sp. Head and thorax fuscous; abdomen a variable dark ochreous; antennæ brownish with a thin whitish pubescence; palpi yellowish; wings somewhat iridescent, hyaline, anterior veins dark ochreous; halteres fuscous apically, pale yellowish at the base; coxa yellowish, femur darker, tibia still darker, and tarsi fuscous distally.

Antennæ longer than the head and thorax; basal segments enlarged; first, cuboidal; second, globose; third to fifteenth nearly cylindrical, length, about twice the thickness, pediceled distally; terminal segment conical. Palpi: basal segment short; second broadly ovate, apically with a large sensory pit; third, elliptical, shorter than the second; fourth, one-third longer than the preceding; each with scattering large setæ and numerous minute ones which have a verticillate arrangement on the last two segments.

Thorax with scattering hairs; on the scutum of the mesothorax there are three rows of fine setæ on its dorsal surface.

Wings, subcosta (1st longitudinal) short, not extending to the fork of the second branch of radius (3rd longitudinal) and media (4th and 5th longitudinals). First branch of radius (2nd longitudinal) extending a little beyond the middle of the wing and just beyond its middle, joined by the small cross-vein to the second branch, and joining costa before the fork of media. Second branches of radius and media, about equidistant from the apex of the wing. Second branch of media (5th longitudinal) and the two branches of cubitus (6th and 7th longitudinals) reaching border of wing at nearly equal distances from each other in the female—in the male, the branches of cubitus are a little nearer each other. The anal vein (8th longitudinal) over half, in the female, and two-thirds in the male the length of the preceding vein (Pl. VI, Figs. 1, 2).

*Communicated by E. P. Felt, D. Sc.

Fore coxa nearly three-fourths the length of the femur or tibia; tarsi longer, first segment nearly as long as the remaining four; middle legs about as the fore legs; posterior tibia longer than the slightly elongated femur; first segment of the tarsi, equal to the remaining segments.

Abdomen of both sexes sparsely invested with setæ. That of the female enlarges to the fourth segment from which it tapers to the slender ovipositor. Terminal portion of the genital plates oval.

Abdomen of the male nearly cylindrical and bearing the usual enlarged segment with claspers which are terminated by single stout curved spines. The whole of the terminal segment is more setose than are the preceding segments, especially the claspers on their tips and inner margins. On the median line of the ventral sclerite there is a thick group of stout setæ. (Pl. VI, Fig. 11.) Near the basal third of the clasper there is a very long seta, extending nearly to the median line. There is also a pair of long, stout setæ, a dorsal and a ventral one, at the base of each clasper.

Length: male, body, 2.5 mm., wing, 2.4 mm.; female, body, 3 mm., wing, 2.8 mm.

This species was reared by Dr. Smith from mushrooms.

The specimens reared by him from decaying potatoes resemble the preceding species in many ways; however, on further study it was found to be quite distinct. Its description follows:

SCIARA PAUCISETA n. sp. Head, thorax and abdomen black; antennæ light brown with a thin whitish pubescence; palpi light brown; wings hyaline, somewhat iridescent, anterior veins nearly black; halteres fuscous apically, yellowish at the base; coxa and femur yellowish, tibia darker, tarsi nearly black.

Antennæ longer than head and thorax; basal segments enlarged, first, cuboidal; second, globose; third, about one-fourth longer than fourth; fourth to fifteenth nearly cylindrical; proximal segments barely twice as long as thick; distal, nearly two and one-half times as long as thick; apical segment nearly conical. Palpi: basal segment short; second elliptical oval, apically with a large sensory pit; third subelliptical, one-third shorter than either preceding or terminal segment; fourth slender; each with a few large setæ and numerous minute ones, which have a verticillate arrangement on the third and fourth segments.

Thorax with scattering hairs on the scutum of the mesothorax; the three rows of minute setæ are easily seen on its surface in some specimens.

Wings: subcosta (1st longitudinal) short, not extending to the fork of the second branch of radius (3d longitudinal) and media (4th and 5th longitudinals). First branch of radius (2d longitudinal) joining costa before the fork of media near the middle of the length of the wing and joined beyond its middle to the second branch by the short cross-vein. Tip of second branch of media (5th longitudinal) nearer apex of wing than is the point where the second branch of radius joins costa. The two branches of cubitus (6th and 7th longitudinals) and the second branch of media reaching the margin of the wing nearly equidistant. Anal vein (8th longitudinal) two-thirds the length of the second branch of cubitus in the female, in the male it is but one-half. (Pl. VI, Figs. 3, 4.)

Fore coxa a little over one half the length of femur or tibia, tarsi about one-fourth longer, first segment nearly equal to the remaining segments; middle legs nearly the same; posterior tibia one-fourth longer than the slightly elongated femur; first segment of tarsi equal in length to the remaining segments.

Abdomen of both sexes sparsely invested with setæ. The abdomen of the female enlarges slightly to the fourth segment, from which it tapers moderately to the slender ovipositor; the terminal portion of the genital plates oval.

Abdomen of the male nearly cylindrical and bearing the usual enlarged segment with claspers which are terminated by a single stout curved spine. The setæ are thickest on the claspers, especially on the apical portion and along the inner margin. On the median line of the ventral sclerite of the last segment there is a sparse group of stout setæ, each arising from an enlarged base (Pl. VI, fig. 12). Near the basal third of the clasper there is a very long seta on its inner margin, extending nearly to the median line. There is also a pair of long stout setæ, a dorsal and a ventral one, at the base of each clasper.

Length: male, body 2.75 mm., wing 2.5 mm.; female, body 3.5 mm., wing 3 mm.

This species may be separated from the preceding by the darker color of the palpi, thorax, and abdomen, by the greater length of the third antennal segment, and by the few setæ in the group on the median line of the ventral sclerite of the terminal segment in the male.

Numerous small flies of this genus were found in the mushroom cellar of Dr. Wm. Hailes, of Albany, N. Y., June 6, 1896. It was stated that at times the cellar would be almost black with this and other species, although they were by no means so abundant when the cellar was visited by me. With the advent of hot weather the flies become so numerous as to destroy the mushrooms quickly and render their further culture unprofitable.

The flies agree with no description of American forms known to me. The species is evidently closely related to *Sciara villosa* Winnertz, though apparently different.

SCIARA AGRARIA n. sp. Head and thorax a very dark brown, nearly black, shining; abdomen a variable dark brown, base of terminal segment and base of claspers in male with a yellowish cast; antennæ dark brown with a dense whitish pubescence; palpi dark brown, terminal segment a little lighter; wings iridescent, tinged with fuscous, anterior veins nearly black, the others pale yellowish: halteres fuscous apically, yellowish at the base; coxæ smutty yellow, anterior pair lighter, femora and tibiæ a little darker, and tarsi fuscous distally, tibial spurs yellow.

Antennæ half the body's length in the male, in the female about one-third; the enlarged basal segments globose; the third to the fifteenth as long as thick, cylindrical, terminal one subconical. Palpi; second segment subelliptical, with a medium sized sensory pit; third suboval,

shorter; fourth slender, almost linear and equal in length to the second; each with a few scattering long setæ and numerous small ones having a more or less verticillate arrangement.

Thorax with a few longer setæ and a number of shorter ones which show traces of being arranged in three longitudinal rows on the scutum of the mesothorax.

Wings: subcosta (1st longitudinal) short; first branch of radius (2nd longitudinal) joined to the second branch (3d longitudinal) at two-thirds its length by the short cross-vein and uniting with costa about the middle of the wing, some little distance before the fork of media (4th and 5th longitudinals). Second branch of media (5th longitudinal) nearer the apex of the wing than the tip of the second branch of radius. The distance between the two branches of cubitus (6th and 7th longitudinals) along the margin of the wing is greater than between the second branch of media and the first branch of cubitus. The anal vein (8th longitudinal) about half the length of the second branch of cubitus (Pl. VI, figs. 5, 6).

Fore coxa a little over half the length of either femur or tibia; tarsi one-fourth longer than tibia, first tarsal segment shorter than the remaining four; segments of the middle pair of legs a little longer than in the first, those of the posterior pair still longer, the first tarsal segment nearly equal to the remaining ones.

Abdomen of both sexes sparsely clothed with fine setæ. The female abdomen enlarges gradually to the fourth segment and then tapers to the slender ovipositor. Terminal portion of the genital plate elliptical.

Abdomen of the male nearly cylindrical. Terminal segment somewhat enlarged; claspers curved, each armed with an apical curved spine and with numerous stout ones along the inner margin. Near the basal third of the clasper there is a very long seta on its inner margin, extending nearly to the median line. There are also a pair of long stout setæ, a dorsal and a ventral one, at the base of each clasper (Pl. VI, fig. 10).

Length: Male, body, 2.5 mm., wing, 2.25 mm.; female, body, 3 mm., wing, 2.5 mm.

The following species was quite common in the greenhouse of Mr. J. A. Otterson, Berlin, Mass., and in others in the vicinity. During the winter the flies were more or less abundant, and their larvæ could be found in the soil. Under the influence of the higher temperature of the early spring the flies became very abundant. As giving an idea of their prolificacy, it may be interesting to note that over 625 eggs were found in the distended abdomen of a female. In this dissection no count was made of a number (estimated at approximately 200) of what appeared to be partly developed eggs. This species, described below, is closely related to *Sciara obscura* Winnertz.

SCIARA PROLIFICA n. sp. Female. Head and thorax dull black; abdomen brownish black, posterior margins of 4th to 6th segments, occasionally others, bordered with yellowish white; ventrally the abdomen is lighter and frequently its yellowish contents show through the distended lateral membranes. Antennæ and palpi nearly black, the former with a short whitish pubescence. Wings somewhat iridescent,

thickly specked with fuscous; anterior veins black, the others a smutty yellow. Knobs of halteres fuscous, pedicel yellowish. Coxæ and legs dark brown to black, the anterior coxæ sometimes lighter; tibial spurs yellow.

Antennæ equal in length to head and thorax; the two enlarged basal segments globose; 3d to 15th segments nearly cylindrical, about twice as long as thick; terminal segment subconical. Palpi; basal segment short; second irregular, rounded dorsally; third a little shorter than second, subrectangular in outline; terminal segment as long as second, slender: both large and small setæ exceptionally stout and numerous; smaller, verticillately arranged.

Thorax with scattering setæ. Wings: subcosta (1st longitudinal) short; first branch of radius (2d longitudinal) joined to the second branch (3d longitudinal) about midway of its length by the short cross-vein and uniting with costa at the outer third of the wing just beyond the fork of media (4th and 5th longitudinals); second branch of media (5th longitudinal) nearer the apex of the wing than the tip of the second branch of radius; the distance between the two branches of cubitus (6th and 7th longitudinals) along the margin of the wing is greater than that between the second branch of media and the first branch of cubitus (Pl. VI, figs. 8, 9). Fore coxa a little over half the length of either femur or tibia; tarsi one-fourth longer than tibia; first tarsal segment shorter than the remaining four; femur and tibia of middle pair longer, of the posterior still longer, than those of the anterior legs; first segment of middle tarsi not quite so long as the remaining segments, while that of the posterior is longer.

Abdomen sparsely clothed with fine setæ. The distended abdomen of the female enlarges to the third or fourth segment, and then tapers gradually to the slender ovipositor,—terminal portion of the genital plates oval.

The male differs in having a nearly cylindrical abdomen which is vested with stouter setæ. The basal portion of the enlarged terminal segment is unusually stout and the claspers are comparatively weak and irregular. Tips of the claspers terminated by a stout recurved spine and by numerous straight bristles on its inner margin.

Length: male, body 4.4 mm., wing 3.7 mm.; female, body 5.6 mm., wing 5 mm.

Males of the following species were reared by Dr. Smith from decaying blackberry roots. They resemble *Sciara ochrolabis* Loew closely, but differ from the types in the antennæ being barely as long as the head and thorax, while in *ochrolabis* they are longer. The basal joints of the antennæ in Loew's species appear to be much shorter than in the insect under discussion. It will also be found that the terminal abdominal segments are more hairy and the claspers more triangular than in *ochrolabis*.

SCIARI FULVICAUDA n. sp. Face ochreous; vertex dark ochreous; scape of antennæ yellow, flagellum dark ochreous with a rather dense whitish pubescence; palpi fuscous; dorsum of thorax yellowish to rufous, the scutellum of the metathorax with variable dark stripes, in some

specimens hardly discernible; pleura yellow; wings hyaline, iridescent, anterior veins fuscous, the lighter veins brown; knob of halteres fuscous with yellowish tip, pedicel yellowish; tip of trochanter black; coxa and femur dull yellow; tibia darker; tarsi fuscous apically; abdomen fuscous except the yellow terminal segment bearing the large ochreous claspers which are tipped with fuscous.

Antennæ barely as long as head and thorax; first segment cuboidal, second globose, third about one-fourth longer than the following; fourth to terminal one are nearly cylindrical, the proximal ones slightly gibbous and not twice as long as thick, length of distal ones about twice their thickness. Palpi; the small basal segment was not seen; the second is flattened, narrow at its base and is broadly oval distally, nearly equal to subsequent segments in length; third suboval, nearly equal to last; terminal segment rectangular in outline, about one-fourth longer than wide; each with a few scattering large setæ and numerous minute ones, which on the last segments have somewhat of a verticillate arrangement.

Dorsum of thorax invested with a number of large scattering hairs. Wings; subcosta (1st longitudinal) indistinct, short; first branch of radius (2nd longitudinal) joined before its middle by the short cross-vein to the second branch (3rd longitudinal), and uniting with costa beyond the middle of the wing and about on a level with the fork of media (4th & 5th longitudinals); tip of second branch of radius and media about equidistant from the apex of the wing; the second branch of media (5th longitudinal) and the two branches of cubitus (6th & 7th longitudinals) about equidistant on the border of the wing. Anal vein (8th longitudinal) about one-third the length of the second branch of cubitus (Pl. VI, fig. 7). Fore coxa about three-fourths the length of either femur or tibia; tarsi longer, first segment not so long as the remaining ones; middle legs about the same; posterior tibia about one-fifth longer than the slightly elongated femur, first segment of tarsi equal to the remaining ones.

Abdomen with numerous stout setæ. The enlarged terminal segment more thickly clothed with setæ and bearing large, subtriangular claspers (Pl. VI, fig. 13).

Length of body 4 mm., of wing 2.75 mm. Female unknown.

Phora albidihalteris n. sp.*

A Mushroom Phora.

(Ord. DIPTERA: Fam. PHORIDÆ.)

This insect was reared in numbers by Dr. J. B. Smith, from mushrooms. It is believed to be another form new to science and is herewith described.

PHORA ALBIDIHALTERIS.— Head and thorax jet black; palpi orange yellow; abdomen black in some specimens, in others the lateral margins and dorsum of terminal segments are dull yellow; wings hyaline, iridescent, heavy veins ochreous; capitulum of halteres yellowish white; legs a variable ochreous with the terminal segments darker.

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* By E. P. Felt, D. Sc.

Ocellar triangle defined by a deep suture which extends down the front; three transverse rows of bristles occur on the front; six in the posterior row, consisting of a median pair and four lateral; the middle row is composed of four nearly equidistant bristles; six nearly so in the anterior row, the median pair and the smaller ones just in front point downward. Eyes bordered behind and below with a single row of bristles,— very minute setæ occur at the angles of the facets. Antennæ five-segmented; first short, irregular; second very large, subspherical; third and fourth cylindrical, slightly expanded apically; basal portion of the fifth cylindrical and more slender than the preceding, distal portion setaceous, much elongated, plumose. Labium yellow, usually retracted; palpi yellowish brown, somewhat fusiform and bearing several apical bristles; basal portion short, obscurely divided into several sub-segments.

Dorsum of thorax thickly pubescent, several stout bristles occur near the posterior border of the scutum of the mesothorax and near the base of the wings. Costal vein less than half the length of the wing; first heavy vein joining costa near apical third of same; second heavy vein forked near the apex; costal margin fringed with stout setæ to tip of second heavy vein; the four wing pores on this vein are even more distinct than in *Phora agarici* Lintn.; first light vein nearly straight; second curved at basal fifth and apical fourth; third, fourth, and fifth, sinuate. Basal portion of halteres brownish-black, apical portion inflated, yellowish-white. Several apical bristles occur on the front and outer portions of the coxæ; fore tibiæ unarmed; middle and posterior tibiæ fringed with stout spines posteriorly, each with a large apical spine; tarsi about one-fourth longer than the tibiæ. Abdomen rounded dorsally, tapering from a broad base.

Length of body 1.92 mm.; of wing 2.4 mm.

Described from a number of specimens, all females. The puparium of this species resembles closely that of *Phora agarici* except that it is a little larger,— being about 2.4 mm. long.

Piophila casei (Linn.).

The Cheese Skipper: The Ham Skipper.

(Ord. DIPTERA: Fam. PIOPHILIDÆ.)

MACQUART: Hist. Nat. Ins.—Dipt., ii, 1835, pp. 541–542 (common).
WESTWOOD: Introduct. Class. Ins., ii, 1840, pp. 573–574 (mention).
KIRBY-SPENCE: Introduct. Entomol., 1846, p. 168 (mention as *Tyrophaga casei*).
?TREAT: in Harper's New Month. Mag., xxii, 1861, p. 609, fig. 2 (popular account).
HARRIS: Ins. Inj. Veg., 1862, p. 621 (brief mention).
LOEW: in Amer. Journ. Sci.-Art., 2d Ser., xxxvii, 1864, p. 320 (accompanying man; translation by Baron Osten Sacken).
OSTEN SACKEN: in Amer. Journ. Sci.-Art., 2d Ser., xxxvii, 1864, p. 318 (common to Europe and America); Cat. Dipt. N. Amer., 1878, p. 199.

PACKARD: Guide Study Ins., 1869, pp. 413-414, fig. 335; Entomol. for Beginn, 1888, p. 128, fig. 149 (brief mention).
RILEY: 2nd Rept. Ins. Mo., 1870, p. 10 (an imported pest); in Amer. Entomol, ii, 1870, pp. 78-79 (habits of skippers; their natural food), pp. 180, 339 (mention); in id., iii, 1880, pp. 23 24 (injuring smoked hams).
WILLARD: in Amer. Entomol., ii, 1870, p. 78 (treatment of skippery cheese).
GLOVER: MS. Notes from My Journ., 1874, p. 40 (said to have been bred from salt alone by Germar).
———: Country Gent., xliv, 1879, p. 727 (general account).
JACOBS: in Comp.-Rend. des Séances, Soc. Ent. Belg., 1882, pp. cxxiv–cxxv (synonymy, notes).
MANN: in Psyche, iv, 1884, p. 207 (reference).
FYLES; in 17th Ann. Rept. Entomolog. Soc. Ont., 1887, p. 38 (brief notice).
RITZEMA BOS: Tiersche Schädl. Nützlinge, 1891, pp. 620–621 (brief mention).
KELLOGG: in Insect Life, v, 1892, p. 116 (injuring smoked meats, duration of stages),
MURTFELDT: in Insect Life, v, 1892, pp. 135–136 (bred from ham); in id., vi, 1893, pp. 170–175 (detailed account); the same in 24th Ann. Rept. Entomolog. Soc. Ont., 1895, pp. 98–102.
RILEY–HOWARD: Insect Life, vi, 1894, p. 209 (damage by, duration of stages), p. 226 (mention.)
COMSTOCKS: Manual Study Insects, 1895, pp. 486–487 (brief mention).
HOWARD: in Bull. 4 New Series, Div. Entomol., U. S. Dept. Agricul., 1896, pp. 102–104, fig. 48 (general account).
LINTNER: in Country Gentleman, lxi, 1896, p. 293 (general account).
SMITH: Econom. Entomol., 1896, pp. 367–369, fig. 423 (habits, remedies).

A gentleman writing from Moorefield, W. Va., states, that about the 15th of January, some meat in his cellar which had lain in salt two months, was found infested with "skippers." He was of the opinion that "the insect was in the meat when butchered, and if the meat had been properly cured by salt, the germ would have been destroyed."

Request was made for some of the infested meat containing the "skippers," but answer was returned that there was none of it left,—what disposition had been made of it was not stated. It was learned that the meat was pork, and was on the point of being removed for converting into bacon, when the infestation was discovered.

There can be but little doubt that the insect was the "cheese-skipper," which is also known as the "ham-skipper" from its frequent occurrence in smoked hams. There would be no hesitation in referring it, without question, to this insect, were it not, first, for the unusual time of its appearance—early in January,—the earliest record heretofore given of it. It was thought that its early appearance may have been the result of a furnace-heated or otherwise unusually warm cellar drawing the flies

prematurely from their winter hiding-places; but it was learned from the gentleman that the cellar was not particularly warm, but that it was a dry one. Second; it has not hitherto been reported, so far as we know, upon meat simply salted and not yet smoked, nor has the experiment to rear it thereon been successful. Miss Murtfeldt has written: "I have not been able to make it oviposit on fresh meat of any kind, nor does it seem able to breed upon that which is simply salted, but not smoked, not even when such meat is folded in wrapping papers."

Description of the Insect.

The perfect insect is a small black fly about 5 mm. long, with a rather large head bearing reddish, prominent eyes, shown in both sexes at *d* and *e* in fig. 1. The veins of the wings are nearly colorless and much weaker than those of the common house-fly; it is also about half the size of the latter. The lower side of the head, the basal portions of the legs, portions of the tibiæ and tarsi of the posterior two pairs are a variable

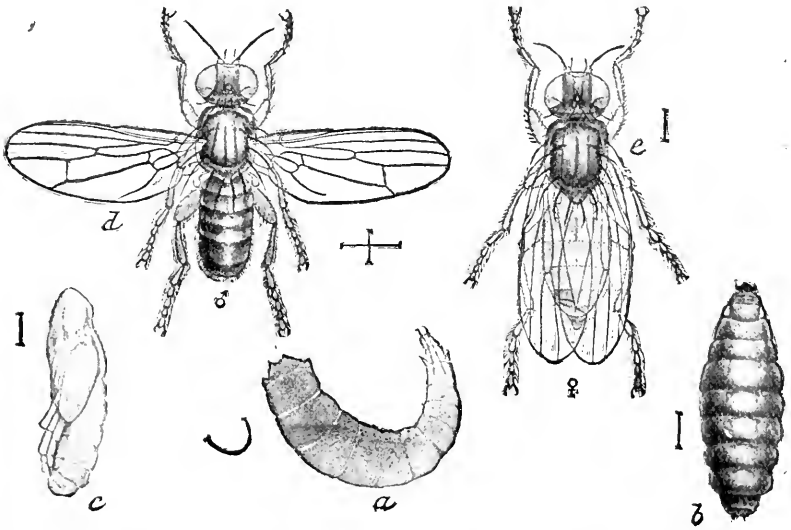

FIG. 1.— PIOPHILA CASEI: *a*, larva; *b*, puparium; *c*, pupa; *d*, male fly; *e*, female with wings folded—all enlarged. (After Howard, Bull. 4 New Ser., Divis. Entomol. U. S. Dept. Agricul.)

yellow. The females are a little stouter than the males. The puparium from which the fly emerges has been described as of a golden yellow color—length about 4 mm.—its appearance is represented at *b*.

Though the parent flies may be seen in the vicinity of cheese and around smoked meats, they usually do not attract so much attention

as do their larvæ, commonly known as "skippers," from their habit of bringing the two ends of the body together and by sudden straightening with a quick muscular action throwing themselves to a distance of four or five inches or more. The larva or skipper "is cylindrical, tapering gradually toward the anterior end, truncate posteriorly, and furnished at this extremity with two horny projecting stigmata and a pair of fleshy filaments (see *a* in the figure). The egg is pearly white, slender oblong, slightly curved, 1 mm. in length, with a diameter of about one-fourth the length" (Murtfeldt).

Life-History.

For our knowledge of the life-history of the insect, we are mainly indebted to the careful observations of Miss Murtfeldt.

The eggs are deposited in more or less compact clusters of five to fifteen in the cracks and checks of cheese, upon the surface of cured or partially cured meats, and, in the case of canvassed meats, on the covering or in its folds; sometimes they are scattered singly. The number of eggs deposited averaged about thirty in the breeding cages, though the conditions were not normal and the number may have been diminished in consequence. A popular article in *Harper's New Monthly Magazine* (*loc. cit.*) credits this insect with depositing nearly three hundred eggs, which is probably a gross over-estimate.

The eggs hatch within thirty-six hours, and the tiny white maggots attack at once their food — in meat, the fatty portions. They complete their growth in seven to eight days and are then seven to nine millimeters (about one-third of an inch) in length. The transformation from the full-grown larva to the perfect fly occupies ten days. In the breeding cage, adult flies on an average did not live longer than a week. They would sip a little at sweets but were not greatly attracted to them, while the odor of smoked meats speedily drew them. The flies were not active at night, although they could perform their functions in partially darkened places. No definite succession of generations could be noted, but the insect in all stages was present from May until into October or November. Severe and protracted cold proved fatal to the insect in all its stages. The above is the result of Miss Murtfeldt's observations on the insect in the month of August and later.

In February of the same year, Prof. Kellogg, then of the Kansas State University, studied the development of this insect. According to his observations, the egg stage lasted four days; the larvæ required two weeks to complete their growth, and they remained in the pupa state one week. Dr. H. F. Kessler, as quoted by Dr. Howard, has carefully studied the life-history of this fly in Europe. He found that the average time

from the egg to the adult is four to five weeks, and that there are two or three generations during the summer,—the last occurring in September, the larva hibernating in the puparium and transforming to the pupa in May. Other writers claim that the insect passes the winter in the adult stage.

Food Habits.

The insect has long been known as a cheese pest. In a notice of it in 1879, by Prof. Riley, it is suggested that the original food of the skippers before cheese was ever made, must have been some analogous substance — possibly a peculiar kind of fungus. The following year he established the identity of the meat skipper with the well known pest in cheese.

In addition to smoked ham and bacon, the fly will also oviposit and breed in smoked beef, but apparently has a decided preference for pork. Such was the experience of a correspondent of Miss Murtfeldt, who wrote concerning injury to beef by skippers as follows: "If a beef ham were hanging beside that of a hog, the former would most likely be O. K. while the latter would be stung." Dr. Howard mentions chipped beef as one of the meats in which the fly will breed. To the above it seems that salt pork may also be added. "Germar is said to have bred this insect from salt alone" (Glover, *loc. cit.*), but if so, the larva must have developed in some other food and entered the salt for pupation.

The fly is said to be an excellent judge of cheese, and it is usually the best qualities that are affected. So marked is this, that "skippery" cheese may be pronounced of good quality, although hardly so because of the presence of the skippers.

Losses Caused by the Insect.

The principal damage in this country is believed to be confined to meats, although Mr. X. A. Willard (*loc. cit.*) in 1879 writes: "Immense losses are sustained every year on account of skippery cheese. Sometimes thousands of pounds in factories are tainted in this way, and the cheese has to be sold for what it will bring, while a portion is not infrequently so badly affected that it has to be thrown away at the factory."

In 1880, Prof. Riley (*loc. cit.*) recorded an injury of smoked hams to the extent of over two thousand dollars, inflicted by this insect upon a single firm in Peoria, Ill. Miss Murtfeldt, in 1892, was informed by an employé in one of the largest packing and curing establishments in the West, as follows: "It entails an enormous loss upon all our packing-house companies." Similarly, Prof. Kellogg's attention was called to the insect through the packing-houses of Kansas City, Mo., being seriously troubled by the pest.

Preventives and Remedies.

It is easier and much more desirable to prevent the infestation of cheese or cured meats than to remedy it after the trouble has begun. The primary cause of "skippery" cheese is said to be the want of proper care, and the same is equally true of "skippery" meat.

The flies can be excluded from rooms by the use of fine screens — a 24-to-the-inch wire mesh is said to be sufficiently fine. In households, cheese and cured meats can usually be stored in fly-proof receptacles, or else kept in absolute darkness, in which it is said the flies can not complete their life-cycle. Darkness would therefore be of service in large store-rooms for these articles.

Scrupulous cleanliness in and about all places where these products are handled or stored, will do much to lessen the attraction for the flies. In cheese factories, it has been recommended to wash the ranges and tables upon which the cheese is placed with hot whey, thus removing grease and giving a clean surface, not attractive to the insect. In hot weather, the bandages and sides of the cheese should be rubbed over at the daily turning, for the purpose of destroying or brushing off eggs which may have been deposited on the surface. The cheese may also be washed with hot whey or with lye, — the latter is a repellant as the fly avoids alkalies.

Smoked meats should be carefully guarded from infestation during the process of curing, and in hams and other meats that are encased, the covering should be so thick and so closely applied, as to effectually exclude the fly or its larvæ.

Infested rooms and factories should be thoroughly cleaned, fumigated with burning sulphur, and, where possible, washed with kerosene emulsion.

Skippery cheese and meat is not necessarily a total loss, although their presence seriously impairs the market value of the product and may render it unsalable. In many cases large portions will be found free from the skippers and in good condition, as their work does not induce putrescence with its attendant odor; if the affected parts are removed, the remainder may safely be used for food. In cheese the surface colonies of skippers can readily be cut out, and the young more deeply located, can be drawn to the surface, by pasting thick oiled paper over the place so as to exclude the air, and, by removing it from time to time for the destruction of the skippers collected beneath, and replacing it, the cheese may be freed from the infestation.

Lebia grandis (Hentz).

(Ord. COLEOPTERA: Fam. CARABIDÆ.)

HENTZ: in Trans. Amer. Philosoph. Soc., N. S., III, 1830, p. 253 (description).
WALSH: in Pract. Entomol., ii, 1867, p. 121 (habits and description).
GLOVER: in Rept. Comm. Agricul. for 1867, 1868, p. 63 (in Ill.); in id. for 1868, 1869, p. 80, fig. 6 (features and feeding habits).
RILEY: in Amer. Entomol.-Bot., ii, 1870, p. 290-291, fig. 181 (destroys Potato beetle in Missouri); the same in 3rd. Rept. Ins. Mo., 1871, p. 100, fig 41; in Insect Life, iv, 1891, p. 204 (in So. Dakota); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 87 (taken on golden rod).
LEBARON: 1st. Rept. Ins. Ill., 1871, p. 64 (mentioned); 4th do., 1874, p. 45, fig. 11 (mention).
REED: in Rept. Entomolog. Soc. Ont. for 1871, 1872, p. 71 (mention).
THOMAS: 6th Rept. Ins. Ill., 1877, p. 90 (description), p. 162 (mention).
SAUNDERS: in Rept. Entomolog. Soc. Ont. for 1878, 1879, p. 6 (operations in Canada); in do. for 1881, 1882, p. 10 (reference to captures).
COMSTOCK: in Rept. Comm. Agricul. for 1879, 1880, p. 245, Pl. V, fig. 3 (active in New York); Manual Study Ins., 1895, p. 520, fig. 625 (mention).
DIMMOCK: in Stand. Nat. Hist., ii, 1884, p. 396, fig. 481 (mention).
LINTNER: in Orange County Farmer for Oct. 19, 1893, xiii, p. 1, c. 7 (identification and habits); 10th Rept. Ins. N. Y., 1895, p. 496 (abstract of preceding).
SMITH: in Rept. N. J. Agricul. Expt. Stat. for 1893, 1894, pp. 566, 567, fig. 146 (mention); in id. for 1895, 1896, p. 455, fig. 60 (description, work in New Jersey); Econom. Entomol., 1896, p. 168 (mention).

During the month of October, examples of a beetle were received by me for identification, from Port Jervis, Orange Co., N. Y., of which marvelous stories had been in circulation in the vicinity among the farmers, and had found their way in a sensational article in the newspapers. It had been stated that it had made its appearance for the first time during the past summer, and that it was accomplishing wonders in destroying the potato beetle. It was to be seen running rapidly over the plants, seizing a beetle, giving it a bite and instantly killing it, and then treating one after another in the same summary manner.

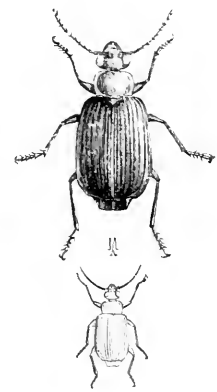

FIG. 2.—LEBIA GRANDIS. In natural size and enlarged.

As no insect of such remarkable ferocity and power was known to us as having been sent to our aid in efforts to control the Colorado potato

beetle, it was suspected that our new ally might be *Lebia grandis* which had been for many years rendering excellent service against the potato beetle in western States,—and such the insect, when received as above, proved to be.

The beetle has been described as follows:

Size rather below medium; elytra truncate or cut off at the extremity, leaving the tip of the abdomen exposed; anterior tibiæ, with the notch on the inner edge; claws distinctly pectinate; abdomen somewhat pedunculated; thorax rounded on the sides and wider than long; the posterior margin straight, with the angles somewhat obtuse, but not rounded, narrower than the elytra; elytra slightly widened posteriorly, of a deep or dark blue color, distinctly striate and without visible punctures. The thorax horny, yellow, smooth, with an impressed longitudinal dorsal line. Head yellowish, but a little darker than the thorax, the legs and breast also yellow. Length about or slightly over two-fifths of an inch; width of the elytra a little less than half the length.

It belongs to the large family of *Carabidæ*, which are commonly known as ground beetles and which render valuable service to the agriculturist in their preying upon many insect pests.

As may be seen from the references given above, this insect has long been recognized as one of the most efficient, if not the most efficient, of the thirty or more species of insects that have been observed to prey upon the Colorado potato beetle.

The first record, so far as we know, of the fondness of this insect for the Colorado potato beetle, is the brief mention by Mr. Glover, in his annual report to the Department of Agriculture, for the year 1867, to this effect: "Dr. Benjamin Morris, of Pittsfield, Illinois, found a species of ground beetle, *Lebia grandis*, feeding voraciously upon the larvæ in a potato field in that neighborhood. Hundreds of this comparatively rare insect were taken by him in the same locality, and always preying upon the grubs of the potato beetle."

In 1869, another notice of its operations in Illinois appears, in a statement made by Mr. Walsh, the entomologist of the State at that time, that it had been found destroying the larvæ of the potato beetle, while "so intent on its prey as to retain its hold even when the leaf was gathered on which it stood." In the notice of its identification by Mr. Walsh, he wrote of it: "This beetle is one of the vast group of ground beetles (*Carabus* family) almost all of which are cannibals; but the genus to which it belongs, unlike most of the other Ground beetles, haunts plants and is active by day, instead of living on the ground and being nocturnal in its habits."

In 1871, when the potato beetle had for the first time invaded the Dominion of Canada, and had not yet entered New York, Prof. Riley reported that this beetle was proving to be an efficient enemy of the new pest in several of the western States; and that although it had previously been rare in the State of Missouri it had suddenly become abundant and was actively engaged in destroying both the eggs and the larvæ of the potato beetle.

This beetle has a distribution throughout the United States which is almost co-extensive with that of the insect upon which it specially preys. Unfortunately, although so abundant oftimes, and aided by nearly two score of other species, it is not able to greatly reduce the number of the greedy and insatiable Doryphora.

Plagionotus speciosus (Say).

The Sugar Maple Borer.

(Ord. COLEOPTERA: Fam. CERAMBYCIDÆ.)

SAY: Long's 2nd Expedit., 1824, p. 292 (original description, as *Clytus*); the same reprinted in Amer. Entomology, iii, 1828, p. 118, Pl. 53, fig. 1; Compl. Writ., Lec. edit., 1883, I, pp. 118, 193.

FITCH: in Amer. Quart. Journ. Agricul.-Sci., 1, 1845, p. 253, Pl. 3, fig. 3 (brief account, as *Clytus*).

HARRIS: Ins. Inj. Veg., 1862, pp. 101–102 (brief account, as *Clytus*).

PACKARD: Guide Study Ins., 1869, pp. 496–497 (mention, as *Clytus*); Bull. 7 U. S. Entomolog. Comm., 1881, pp. 103–105, fig. 45 (general account, as *Glycobius*); in Amer. Nat., xviii, 1884, pp. 1151–1152 (oviposition, as *Glycobius*); 5th Rept. U. S. Entomolog. Comm., 1890, pp. 374–379, figs. 137–140) general account, as *Glycobius*).

WALSH–RILEY: in Amer. Entomol., i, 1869, p. 146 (description, as *Arhopalus*).

COWDRY: in Canad. Entomol., ii, 1870, p. 38 (as *Clytus*, rare at Stratford, Ont.).

CLEMENTI: in Canad. Entomol., iv, 1872, p. 37 (as *Clytus*, at Peterboro, Ont.).

REED: in Rept. Entomolog. Soc. Ont. for 1872, 1873, pp. 35–36, fig. 26 (description and life-history, as *Clytus*).

LEBARON: 4th Rept. Ins. Ill., 1874, p. 154 (reference, as *Clytus*).

BETHUNE: in Canad. Entomol., ix, 1877, p. 222, fig. 2 on Plate (brief account, as *Clytus*); the same in Ann. Rept. Entomolog. Soc. Ont., 1877, p. 23, fig. 2 on Plate.

THOMAS: 6th Rept. Ins. Ill., 1877, pp. 38, 44, 83, 151, iii, iv (in northern Illinois, as *Clytus*).

SAUNDERS: in Rept. Entomolog. Soc. Ont. for 1878, 1879, pp. 32–33 fig. 13 (brief account, as *Clytus*).

ROGERS: in Canad. Entomol., xii, 1880, pp. 149–151, fig. 21 (popular account, as *Clytus*); the same in Rept. Entomolog. Soc. Ont. for 1880, 1881, pp. 32–33. fig. 13.
ZESCH-REINECKE: List Coleopt. Buffalo and Vicinity, 1880, p. 9 (listed, as *Glycobius*).
BELL: in Canad. Entomol., xiii, 1881, p. 236 (mention, as *Clytus*).
LINTNER: 1st Rept. Ins. N. Y., 1882, p. 297 (reference); in Country Gentleman, xlvii, 1882, p. 625 (very injurious to maples); 2d Rept. Ins. N. Y., 1885, p. 227 (abstract); 3d do. for 1886, 1887. pp. 103–105 (notice of injuries, remedies); in Country Gentleman, liv, 1889, p. 579 (characteristics, remedies); 6th Rept. Ins. N. Y., 1890, p. 169 (abstract); in Country Gentleman, lvii, 1892, p. 552 (attack identified); 8th Rept. Ins. N. Y., 1893, pp. 202–205, fig. 45 (ravages and remedies); 9th do., 1893, p. 442 (abstract); in Country Gentleman, lviii, 1893, p. 557 (identified, remedies); in Gardening, iii, 1894, p. 56 (mention, figure); 10th Rept. Ins. N. Y., 1895, p. 497 (reference, in all preceding referred to *Glycobius*), p. 504 (abstract), p. 511 (reference); in Country Gentleman, lx, 1895, p. 583 (remedies); 11th Rept. Ins. N. Y., 1896, p. 280 (abstract), p. 286 (mention).
DIMMOCK: in Stand. Nat. Hist., ii, Crust. Ins., 1884, pp. 330–331, fig. 368 (brief mention).
FLETCHER: Rept. Entomol. for 1885, p. 31 (brief mention, as *Glycobius*).
HARRINGTON: in 17th Ann. Rept. Entomolog., Soc. Ont., 1887, pp. 29–30, fig. 3 (brief mention, as *Glycobius*).
TOWNSEND: in Psyche, v. 1889, p. 233 (listed from Michigan).
SMITH: Cat. Ins. N. J., 1890, p. 203 (on oaks).
PICKERING: in Psyche, vi. 1892, p. 346 (mentioned, as *Clytus*).
COMSTOCKS: Manual Study Ins., 1895, p. 570, fig. 694 (mention).
FYLES: in 26th Ann. Rept. Entomolog. Soc. Ont. for 1895, 1896, p. 24, fig. 8 (mention, as *Glycobius*).
WEED: Bull. 33 N. H. Agricul. Expt. Stat., 1895, pp. 7–9, figs. 3, 4 (general account, as *Glycobius*).
KIRKLAND: in Bull. 2 Mass. Crop Rept., ser. of 1897, pp. 30–34, figs. 1, 2 (general account).

This large and beautifully marked beetle in its bright golden-yellow bands and bars and angulated lines on a background of black, is a desirable and attractive addition to one's collection (Pl. VII, fig. 1). Despite its beauty, it is a highly pernicious insect. Not content, as are most of its associates, with burrowing in dead or sickly trees, its attack is usually made on those perfectly healthy.

A Long-horned Borer.

This insect belongs to the family *Cerambycidæ*, or long-horned wood-borers, — so named on account of their long antennæ and the habit their larvæ have, of living and boring in wood. The antennæ of some species are of extraordinary length, as in the instance of *Monohammus confusor*

(Kirby), in which they measure from about once and a half the length of the body in the female, to nearly four times its length in the male. Many of the members of this large family are remarkable for their size, beauty of color, or elegance of form, and have been, on these accounts, favorites with collectors. Unfortunately, a large number of the species, are quite harmful to the trees that they infest. Among the notorious and well-known pests, may be mentioned the oak-pruner, *Elaphidion parallelum* Newm.; the round-headed apple-tree borer, *Saperda candida* Fabr.; and the common elm-tree borer, *Saperda tridentata* Oliv.

Description of the Beetle.

"The head is yellow, with the antennæ and the eyes reddish-black; the thorax is black, with two transverse yellow spots on each side; the wing covers, for about two-thirds of their length, are black, the remaining third is yellow, and they are ornamented with bands and spots arranged in the following manner: a yellow spot on each shoulder, a broad yellow curved band or arch, of which, the yellow scutel forms the keystone on the base of the wing-covers; behind this a zigzag yellow band forming the letter W; across the middle another yellow band arching backwards, and on the yellow tip a curved band and spot of a black color; legs yellow, and the under side of the body is reddish-yellow, variegated with brown. Nearly an inch in length." (Harris.)

Ravages of the Insect.

This borer has for many years been destroying a large number of our sugar maples, as its burrows are usually carried around the trunk beneath the bark, and when several occur in the same tree, they girdle it by their interlacings and thus kill the tree. Even when they are not fatal to the tree, they occasion unsightly cracking of the bark and serious deformities of growth.*

As early as 1859, my attention was attracted by the operations of this insect in a long row of sugar maples bordering a lawn at Schoharie, N. Y. One tree which I had examined, of some ten inches in diameter at the base, which had been more seriously affected than the others, and probably was the first to be attacked, had been nearly destroyed. Several of the grubs had commenced their ravages side by side, and their united cuttings had in places exposed the trunk for over a hand's breadth. The tree had

*For additional features of these burrows see the Report of the Entomologist for the year 1886, [being the Third Report on the Injurious and Other Insects of the State of New York], page 104.

been attacked in various places from above its first limbs nearly to its base. The entire circumference of the tree had been grooved, although not continuously. In the above row of maples scarcely a single tree was entirely exempt from injury — all apparently the work of this grub.

A few years ago it was an occasion of much pain to me to see at Bennington, Vt., the large number of old maples that were standing dead upon the street or rapidly dying from the merciless burrowing of this borer which had scarred and excavated their trunks. Recently the same ravages, although not as yet to the same extent, were observed by me at Glens Falls, N. Y. This insect was recently very destructive to some fine maples at Canajoharie, N. Y. It is also a serious pest in some other states. In a recent publication, Mr. Kirkland (*loc. cit.*) records extensive injuries by this borer in the sugar orchards of western Massachusetts, their work being preceded in most instances by the clearing up of the underbrush. It was thought that the additional light around the trunks of the trees may have served the insect as an invitation to enter upon and prosecute its pernicious work. The maples on the grounds of Bowdoin College, Brunswick, Me., were observed by Dr. Packard to be seriously injured by this pest in 1873 and 1874. In London, Ontario, this insect is spreading rapidly and proving very destructive. In South Quebec the borer is so abundant as to be found frequently in woodsheds, having developed from maple wood stored for domestic use.

Formerly a Rare Insect.

This beetle was regarded by its original describer, Dr. Say, as a rare insect, for at the time of its description only two examples were known. It is one of our native forms which seems to have found the cultivated trees better adapted to its needs than the wild — their proximity, location and abundance having supplied ample means for a rapid increase. It is now a common insect and a serious menace to the safety of sugar maples, either in ornamental grounds or as shade trees along the road side.

Life-History.

The beetles make their appearance in this latitude during the latter part of June, through July and into August.* The eggs are laid during the latter two months. The place of oviposition may be recognized, as stated by Dr. Packard, "by a rusty irregular discoloration of the bark about the size of a cent, and especially by the 'frass' or castings which to the length of an inch or more are attached like a broken corkscrew to

* Examples in the State collection bear dates of capture from June 23d to August 9th.

the bark." The egg is deposited on the trunk at various heights from the ground upward to at least ten feet in low branching trees, and even higher when the infestation has been of long continuance. The newly hatched larva, about one-fifth of an inch in length, may be found within its burrow at a depth perhaps of one-tenth of an inch, by cutting in at the places indicated as above. September 12th, Dr. Packard found that the mines or burrows of the young larvæ were already about an inch long, most of them being directed upward. They pass the winter in shallow burrows in the bark. The following spring they burrow deeper and mine the cambium layer and the living wood,— the burrows steadily increasing in size with the growth of the larvæ. It is probable that the insect requires two years to complete its transformations, and that an entire season is spent by the long white fleshy grubs, with deeply marked transverse incisions, in running their mines or burrows, about one-third of an inch in depth and one-half an inch in width, in all directions beneath the bark. On the approach of the second winter the larvæ probably burrow to the depth of an inch or two in the trunk and there hibernate. In the spring feeding is resumed and the burrows continued a distance nearly equal to that of the previous season, before the pupal chamber is excavated in the wood. Mr. Kirkland found a number of burrows in an infested tree with a chamber midway of their length, and thought that this might indicate the place of hibernation. The larval burrows usually run upward and partially around the trees, but occasionally downward. They frequently intersect, and thus a badly infested tree may be effectually girdled and killed.

Distribution.

The recorded distribution of this beetle is curiously limited. The explanation may be that only within this area has it been sufficiently abundant to attract attention, although it would seem that even if rare, some examples should fall into the hands of collectors and the localities be made known. The reported distribution is as follows; South Quebec, the southeastern portion of Ontario, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Michigan, Indiana, Northern Illinois and Wisconsin. This record indicates comparatively narrow bounds, but it will probably be found that it extends over a much greater area than indicated above. There is apparently no reason why it should not extend to the Rocky Mountains, if not to the Pacific coast.

Food Plants.

This insect, so far as known, is mainly confined to the sugar maple, while exceptionally attacking other of the maples. In New Jersey there are very few maples where it was found, and in every instance the beetles were taken on oaks. It was therefore thought that possibly it may infest some of the species of oak (Smith : *loc. cit.*).

Natural Enemies.

The only natural enemies of this insect recorded are various species of woodpeckers. Dr. Packard mentions having observed them at work, but he failed to indicate the species. Mr. Kirkland observed the hairy woodpecker, the downy woodpecker, and the flicker feeding upon white larvæ taken from beneath the bark of infested trees.

Remedies.

Perhaps the best remedy is the cutting out or destroying the young grubs while still within easy reach. By carefully examining the trunks sometime in the early autumn, the location of the recently hatched grub may be easily detected by the indications stated on a preceding page.

The trunks of the trees may be painted or sprayed with a solution of soft soap and carbolic acid, renewing the application as often as it is washed off by the rains. If this be done during the months of July and August (the period of oviposition), the beetles will be deterred from depositing their eggs in the trunks so treated and there will be no necessity of searching for and digging out the young grubs later in the season.

In maple sugar groves, Mr. Kirkland recommends that as much underbrush be allowed to grow as will not be in the way of the sugar making, as he has observed that the clearing up of the shrubbery has repeatedly been followed by severe attacks of these borers. The beetles are sun-loving insects which delight in sunny places and if there are few such spots in a sugar grove, there would be less attraction for them. All badly infested trees should be cut for fuel during the autumn and burned before the time for the appearance of the beetle the following June.

Saperda tridentata Olivier.

The Elm Borer.

(Ord. COLEOPTERA: Fam. CERAMBYCIDÆ.)

FITCH: in Trans. N. Y. St. Agricul. Soc. for 1858, 1859, pp. 839–840 (brief account); 5th Rept. Nox. Other Ins. N. Y., 1859, pp. 59–60 (the same).

HARRIS: Ins. Inj. Veg., 1862, pp. 111–113, Pl. II, fig. 13 (description and ravages).

PACKARD: in Amer. Nat., iv, 1870, pp. 588–591, figs. 115, 116 (general account after Harris, as *Compsidea tridentata*); Bul. 7 U. S. Entomol. Comm., 1881, pp. 58–59, fig. 17 (brief account); 5th Rept. do, 1890, pp. 224–226, fig. 71 (general account), p. 424 (infesting maple).

HUBBARD: in Psyche, i, 1874, p. 5 (mention); in id., ii, 1877, p. 40 (mention, as *S. trinlicata*).

LECONTE: in Smith. Misc. Coll., xi, 1874, pp. 238–239 (table of species of *Saperda*).

THOMAS: 6th Rept. Ins. Ill., 1877, pp. 38, 44, 156–157, ii (brief notice).

ZESCH-REINECKE: List. Coleopt. Buffalo and Vicin., 1880, p. x.

HARRINGTON: in Canad. Entomol., xv, 1883, p. 79 (infesting maple); the same in 14th Rept. Entomol. Soc. Ont., 1884, p. 35; in Canad. Entomol., xxii, 1890, p. 186 (listed from the counties of Argenteuil and Ottawa).

FORBES: 14th Rept. Ins. Ill., 1885, pp. 112–114, Pl. xii, fig. 2 (general account of ravages, remedy).

SMITH: Cat. Ins. N. J., 1890, p. 212 (common at Newark, Caldwell).

CAULFIELD: in 21st Ann. Rept. Entomol. Soc. Ont., 1891, pp. 73–74 (brief account).

GARMAN: Bull. 47 Ky. Agricul. Expt. Stat., 1893, pp. 44–50, figs. 12, 13 (general account); the same in 6th Rept. do., 1894, pp. 122–127, figs. 12, 13.

LINTNER: in Proc. West. N. Y. Horticul. Soc., 1893, separate, pp. 7–9 (ravages, remedies); republished in Gard. Forest, vi, 1893, p. 76, and in 9th Rept. Ins. N. Y., 1893, pp. 427–429; in Albany Evening Journ., for May 7, 1894 (work in Albany, remedies); 10th Rept. Ins. N. Y., 1895, pp. 484, 485, 499 (abstracts of preceding notices); in Country Gentleman, lxi, 1896, p. 746 (remedies).

This insect appears to be as injurious to the beautiful white elm, *Ulmus Americana*, which has been so liberally planted and is so highly prized as our most valuable shade-tree, as the maple borer, *Plagionotus speciosus*, is to the very desirable sugar maple. The borers in the wood and bark of our trees are dreaded most deservedly, not only on account of their ofttimes excessive injuries, but for the reason that their operations are of such a nature that severe damage, if not fatal injury, is often done before their presence is even suspected. The unthrifty condition of the infested

tree is attributed to unusual dry weather, to the impervious street pavements of many of our cities, to defective gaspipes, or some other cause, while the true agents of the mischief continue their destructive work unknown and undisturbed. Throughout the entire State, and beyond its limits, the American elm has for a number of years been suffering from the ravages of this hidden and insidious enemy, the trees dying one by one from a cause, not apparent, and known to but a few.

Character and Extent of Injury.

The larvæ or grubs of this insect work in the inner bark and sap-wood of the trunk,—the attack apparently commencing not far above the ground and gradually extending upward. Most of the burrows are in the inner bark, although a few occur at the depth of an inch or more. When the grubs are numerous, their broad flat burrows, varying from one-tenth to two-tenths of an inch in width and about one-tenth of an inch deep, so reticulate and run into one another as effectually to girdle trunks of trees two or three feet in diameter, when, with the circulation arrested, the death of the tree inevitably follows. The bark is frequently so badly infested that in old trees it can be detached in large sheets. The work of this pest is shown in figures 4, 5, of plate VII.

As early as 1847 and 1848, Dr. Harris had noticed that this insect was very injurious to the elms on Boston Common. He wrote as follows:

> The trees were found to have suffered terribly from the ravages of these insects. Several of them had already been cut down, as past recovery; others were in a dying state, and nearly all of them were more or less affected with disease or premature decay. Their bark was perforated, to the height of thirty feet from the ground, with numerous holes through which insects had escaped; and large pieces had become so loose by the undermining of the grubs as to yield to slight efforts, and come off in flakes. The inner bark was filled with the burrows of the grubs, great numbers of which, in various stages of growth, together with some in the pupa state, were found therein; and even the surface of the wood, in many cases, was furrowed with their irregular tracks.

Most of the wood and bark borers are partial to diseased and dying trees, as is well known to many. An enfeebled condition of the trees from their age or some other cause, may account for the severity of the attack noted above. Dr. Fitch, in his Fifth Report, records that the larvæ of this insect infested the remaining bark of all of the slippery elms, *Ulmus fulva*, in his vicinity, after the best of it had been stripped off for medicinal purposes. The operations of this insect appear to be notorious, for it has been characterized by Dr. Packard as the most destructive borer in the Northern and Eastern States, often killing trees by the wholesale. In 1884, its ravages were so serious that Prof. Forbes wrote:

"From the present appearance of the elms throughout the towns of Central Illinois, where I have had an opportunity to examine their condition, and from the rapid progress which this pest has made among them during the last two or three years, it seems extremely likely that it will totally exterminate the trees unless it be promptly arrested by general action." A serious attack is recorded upon the elms at Frankfort, Ky., in 1892, when several were killed and a number badly injured. The insect has also been very destructive to elms in Albany and in Gloversville, N. Y. It does not appear to be so injurious in Canada as in the United States. It has been found infesting a dead maple by Mr. Harrington.

Description of the Insect.

The beetle is an innocent appearing slate-colored insect with dull orange markings as follows: a curved line behind each eye, a line on each side of the thorax, and margined wing-covers with three nearly equidistant points extending from the border. They vary in length from about one-third to one-half an inch. The females are considerably stouter and with shorter antennæ than the males (Pl. VII, fig. 2).

The borers (the larvæ of the beetles), are similar in form and general appearance to the notorious round-headed borer of the apple, belonging, indeed, to the same genus. They rarely exceed three-fourths of an inch in length, are destitute of feet, and have the usual enlargement of the first segment of the body immediately behind the head. (Forbes.)

The larva is white, subcylindrical, a little flattened, with the lateral fold of the body rather prominent; end of the body flattened, obtuse, and nearly as wide at the end as at the first abdominal ring. The head is one-half as wide as the prothoracic ring, being rather large. The prothoracic segment, or that next to the head, is transversely oblong, being about twice as broad as long; there is a pale dorsal corneous transversely oblong shield, being about two-thirds as long as wide, and nearly as long as the four succeeding segments; this plate is smooth, except on the posterior half, which is rough, with the front edge irregular and not extending far down the sides. Fine hairs arise from the front edge and side of the plate, and similar hairs are scattered over the body and especially around the end. On the upper side of each segment is a transversely oblong ovate roughened area with the front edge slightly convex, and behind slightly arcuate On the under side of each segment are similar rough horny plates, but arcuate in front, with the hinder edge straight. (Packard.)

The larva differs from the allied linden borer, *Saperda vestita* Say, in its shorter, broader, and more hairy body, and having the tip of the abdomen hairy and more depressed. The prothoracic segment is broader and flatter, and the rough portions of the dorsal plates are larger and not so transversely ovate. The mandibles are much longer and more slender, and the antennæ much smaller than in *S. vestita*.

Life-History.

The period required by this insect to complete its life cycle is at least one year and is probably several. The eggs are deposited upon the bark in June and the larvæ hatching therefrom are nearly full grown before winter, according to Dr. Fitch. On the other hand, Dr. Packard, writing in December, 1870, mentions finding "three different sizes of the larvæ, evidently one, two, and three years old, or more properly six, eighteen, and thirty months old." This latter statement has evidently been overlooked by more recent investigators, and no attempt seems to have been made to determine the true period of development. Possibly the beetle may complete its transformations in one year, yet the allied round-headed borer of the apple-tree, *Saperda candida*, requires three. The winter is passed in the larval or grub stage. Pupation occurs about the middle of April in central Illinois, and imagoes may emerge from early in May until the latter part of June in that latitude. In Massachusetts, Harris records taking living beetles repeatedly from early June to the 10th of July. Mr. Harrington has taken the beetle June 15th in Canada.

Associated Insects.

An ally of the Saperda is found in *Neoclytus erythrocephalus* (Fabr.). This insect appears to feed mostly on dead wood, apparently following the attacks of the more pernicious species. Occasionally it occurs in numbers in trees infested with *Saperda tridentata*. It may feed in such places only on the dying tissues left by its predecessor. As an evidence of its abundance, the following may be noted: From a section of the trunk of an elm, three inches long and six inches in diameter, infested by the Saperda and brought to my office about the first of April, eleven examples of the Neoclytus emerged between April 29th and May 12th, 1882. Large numbers of them were bred from other portions of the affected tree secured later—sixteen examples on the 23d of June, and others thereafter until July 1st. It has also been reared by me from hickory, from twigs of locust, and from pear twigs infested with *Xyleborus*, received from Mr. Pomroy of Lockport, N. Y. It is represented in figure 3 of plate VII. Another insect found associated with it in the dead wood of infested elms is the Curculionid, *Magdalis armicollis* (Say). This insect usually attacks the upper branches, but also occurs with the Saperda and Neoclytus in the trunk.

Distribution.

The ravages of this insect have been reported from the Provinces of Ontario and Quebec, and from the following states: Massachusetts, Rhode Island, New York, New Jersey, Kentucky, Illinois and Michigan. In all probability it occurs also in the intervening states of Pennsylvania, Ohio and Indiana.

Parasites.

Several parasites have been bred from this insect or the species associated with it in infested trees, but they are comparatively few in number and can therefore be of little importance in keeping this pest or its associates in check. The parasites apparently have not been identified or referred positively to the proper host.

Remedies.

Badly infested trees should be cut and the wood burned or the grubs within destroyed in the winter or early spring before they have had an opportunity to escape and perpetuate their kind.

If the attack has not proceeded too far, protection may probably be obtained by coating the bark with some thick repellent substance (of which carbolic acid and Paris green should be components) that would repel egg deposit or prevent the entrance of the newly hatched larvæ. This coating need not be applied to the entire trunk, but might be limited to a broad zone of several feet, at and beyond that part where the burrows of the preceding year were mainly run — to be found by removing portions of the bark, which will readily scale off from the older infested portions.

A still better remedy, probably, would be the following: Remove the outer bark from the entire infested portion of the tree in the spring (occupied at the time by the larvæ or the pupæ) by shaving it down to the inner bark until the first indications of the fresh burrows are disclosed. A kerosene emulsion of good strength brushed over the shaven surface would kill the insects, after which a coating of some thick substance, as lime and cow-dung, should be applied to prevent the splitting of the sapwood from exposure to the sun, drying winds or extreme weather.

That the barking of elms to even a greater extent than the above may safely be resorted to, appears from experiments made in France by M. Robert, detailed in the *Gardeners' Chronicle and Agricultural Gazette*, for April 29th, 1848, and quoted by Dr. Packard in his report on "Insects Injurious to Forest and Shade Trees" (1890), as follows:

"The whole of the outer bark was removed from the elm (this may be done conveniently by a scraping-knife shaped like a spoke-shave). This operation caused a great flow of sap in the inner lining of the bark (the liber) and the grubs of the Scolytus beetle were found in almost all cases to perish shortly after. The treatment was applied on a large scale, and the barked trees were found, after examination by the commissioners at two different periods, to be in more vigorous health than the neighboring ones of which the bark was untouched. More than two thousand elms were thus treated."

M. Robert had also obtained good results from cutting out strips of the bark of old elms of about two inches wide from the boughs down to the ground. "It was found that where the young bark pressed forward to heal the wound and a vigorous flow of sap took place, many of the larvæ near it were killed,—the bark that had not entirely been undermined was consolidated, and the health of the tree improved."

Crioceris 12-punctata (Linn.).

The Twelve-spotted Asparagus Beetle.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

LINNÆUS: Syst. Nat., Edit. xii, i, pars ii, 1767, p. 601, no. 110 (description).

LINTNER: 1st Rept. Ins. N. Y., 1882, p. 244 (recently introduced); 8th do., 1893, p. 250 (mention); 10th do., 1895, p. 517 (from Brighton, Monroe Co., N. Y.).

RILEY: in Amer. Nat. for Feb. 1883, p. 199 (introduction); Bull 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 67 (listed).

HORN: in Canad. Entomol., xvi, 1884, pp. 183–184 (mention).

RILEY–HOWARD: in Insect Life, iv, 1892, pp. 395–396 (occurrence in Maryland and District of Columbia).

HOWARD: in Insect Life, v, 1892, p. 98 (spreading slowly).

SMITH: in Insect Life, v, 1892, p. 94 (in New Jersey); in id., vi, 1893, p. 191 (spread); in Rept. N. J. Agricul. Expt. Stat. for 1892, 1893, p. 393 (spreading in New Jersey); in id. for 1893, 1894, pp. 444–445 (continues to spread); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 62 (spreading over entire State); Econom. Entomol., 1896, p. 212 (brief mention); in Entomolog. News, viii, 1897, p. 181 (in Monmouth Co., N. J).

WEBSTER: Bull. 51 Ohio Agricul. Expt. Stat., 1894, p. 121 (mention).

LAURENT: in Entomolog. News, v, 1894, p. 292 (mention).

JOHNSON: in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 65 (becoming quite common); in 9th Rept. Md. Agricul. Expt. Stat., 1896, p 225 (common and spreading).

WICKHAM: in Canad. Entomol., xxviii, 1896, p. 74 (mention).
CHITTENDEN: in Year Book U. S. Dept. Agricul. for 1896, 1897, pp. 349-352, fig. 89 (general account).
SKINNER: in Entomolog. News, viii, 1897, p. 230 (in localities in Pa).

The common asparagus beetle, *Crioceris asparagi* (Linn.), has long been known to most growers of this plant on and near the Atlantic coast in New Jersey, Delaware and Maryland, while recently it has extended its range inwardly, and has appeared in various localities in eastern, central and western New York, and has entered Ohio. This destructive pest is, however, not the only asparagus beetle now established within the State of New York.

Twelve-spotted Asparagus Beetle in Monroe County.

This near relative of the common asparagus beetle was found infesting an asparagus bed in Brighton, Monroe county, N. Y., in comparatively small numbers in 1893 on the farm of Mr. Silas J. Robbins. Early in May of the following year a few of the 12-spotted variety were to be seen among the hundreds of the more common species. The latter part of the month, however, Mr. Robbins wrote: "Yesterday the asparagus beetles came out in full force. In many places quite as many red ones [*12-punctata*] as of the common kind." The appearance of the insect in such large numbers the second year of its observed presence would indicate that the climatic conditions of its newly adopted home were very favorable to its multiplication.

This insect has evidently prospered in this new locality as Mr. C. J. Chism, of Brighton, informed me in Sept., 1897, that it was very injurious, more so than *C. asparagi*. It had spread from the farm of Mr. Robbins to others in the vicinity and was regarded as a serious pest. The beetle was said to eat into the growing shoots more than does the common species, and thus render them unfit for market.

Description of the Insect.

The beetles of this species are easily distinguished from the more common form. They may be recognized by the twelve black spots on their orange-red elytra. The thorax is a deeper orange red. The eyes, antennæ, tips of the femora and tibiæ, the tarsi, and portions of the ventral surface are black. In form it is a stouter and larger insect than *asparagi*. At a little distance, they resemble somewhat closely, it is said, the ripening asparagus berry.

"The full-grown larva is shown in the illustration at fig. 3*b*. It measures, when extended, three-tenths of an inch (8 mm.), being of about the same proportions as the larva of the common species, but is readily separable by its ochraceous orange color. The ground color is light yellowish cream with an overlay of ochraceous orange which is most pronounced on the exterior portions of the abdominal segments. The head, with the exception of the mouth-parts, is also ochraceous, the thoracic plate is prominent, divided into two parts, and is of a dark-brown color. Enlarged figures of the second abdominal segment of both species are presented at fig. 3 *c* and *d*, for comparison." (Chittenden.)

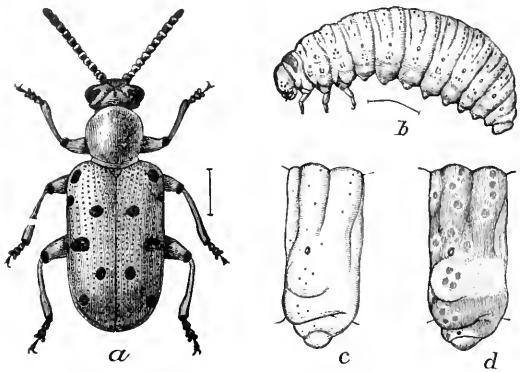

FIG. 3.—CRIOCERIS 12-PUNCTATA: *a*, beetle; *b*, larva. (After Chittenden, Year-book U. S. Dept. Agr., 1896.)

Life-History and Habits.

Comparatively little is known of the life-history of this species. Two annual broods are ascribed to it in Europe, while there are presumably three in this country, especially in the southern portions. The eggs are not known, although it has been suggested that they may be deposited, like those of *C. asparagi*, on the leaves and stems. But few larvæ have been observed. One was found on the foliage and others in various stages, were feeding in the berries. The infested fruit reddens prematurely, is reduced to pulp, and the larvæ, on completing their growth, enter the ground for pupation. The food of the earlier brood appears unknown, unless it be the foliage, as with the common species. In the latter part of the season the berries are preferred by the larvæ. In Europe, the insect is said to pass the winter in the pupa state, but in this country some, judging by analogy, are of the opinion that it more probably hibernates in the adult form. Pupation occupies about two or three weeks during the summer and if the insects hibernate as beetles, the pupation of the later brood would probably occupy but little longer.

The few beetles observed by Mr. Robbins in early May were most likely the last of the overwintered beetles or, if hibernating as pupæ,

recently issued ones. Their abundance noted by him the latter part of the month is possibly due to the appearance of individuals of the second brood. The beetles feed, like the more common species, on the foliage. They will also feed on the berries, in confinement, at least. This insect is more ready to take to flight and is less apt to hide behind the stems when disturbed, than is its congener.

Introduction and Distribution.

This is another addition to the list of insect pests accidentally introduced into this country from Europe. It was discovered in 1881 in the vicinity of Baltimore, Md., by Dr. Otto Lugger. The insect was quite abundant when found, showing that the date of its introduction was probably several years earlier.

Assuming Baltimore or its vicinity as the place of introduction, the spread of the insect may be traced southward across several counties and into the District of Columbia, where it was detected in 1896. Later it invaded Virginia in the vicinity of Washington, and now it has been detected as far south as Westmoreland county of that State. In 1892 it was found in Gloucester county, N. J. When spreading from Maryland to New Jersey, it also established itself in northern Delaware. The next year its presence was announced in the adjoining counties of Cumberland and Camden, N. J. The progress of the insect over New Jersey has been so rapid that in 1897, Dr. Smith found the insect in Monmouth county, nearly as far north as Staten Island. It has also established itself in parts of Pennsylvania near the southern portion of New Jersey, having been found there in 1894. The same year it was received by me from Monroe county, N. Y.

The known distribution of this insect is about as follows: The northeastern portion of Virginia along the Potomac and Chesapeake bay, the District of Columbia, Maryland, the northern portion of Delaware, the southeastern part of Pennsylvania, New Jersey as far north as Monmouth county, at least, and a colony in the vicinity of Rochester, Monroe county, N. Y. It will probably spread over a considerable area in the central portion of the State, and it may be expected to enter both Staten and Long Island in the near future, from its northern extension in New Jersey.

Distribution of Crioceris asparagi.

The distribution and spread of the common species will give some idea of what may be expected of the twelve-spotted form. *Crioceris asparagi* was first detected in this country in Queens county, Long

Island. It is now generally distributed through the States of Maryland, Delaware, New Jersey and in Pennsylvania along the Delaware river. It is known in Connecticut and Rhode Island, and is widely, though locally, distributed in Massachusetts. In the latter State it has worked along the seacoast, establishing itself in places where its food-plant was found. It has also made its way to a considerable distance inland, presumably on the plants purchased for the setting out of new beds. In this manner it has extended back from the sea for a distance of nearly forty miles. The insect has been abundant for a number of years at Berlin, Mass., where large quantities of asparagus are grown for the Boston market, and it has made its way along the coast to Portsmouth, N. H., and up the Merrimac river to Nashua, N. H. It may also enter both New Hampshire and Vermont through the Connecticut valley, besides touching the southern coast of Maine.

In this State the common species occurs over all Long Island. It has been traced up the Hudson river valley as far as Mechanicsville, about twenty miles north of Albany. It occurs in a number of widely separated localities in the western central portion of the State, having been reported from the following places: Vernon, Oneida county; Oswego, Oswego county: Newark, Wayne county; Geneva, Ontario county; Geneseo, Livingston county; Rochester, Monroe county; and Buffalo, Erie county. The insect will probably spread to all parts of the State lying within the Upper Austral Life-zone (see Plate IV in my 11th Report). It is known in nine counties in the northeastern part of Ohio, and is now slowly spreading over that State. The twelve-spotted species may be expected to eventually occupy a not much less extended range of territory.

Remedies.

The methods of value against the common asparagus beetle will be found of service in fighting this insect under similar conditions. The larvæ of the twelve-spotted form feed in the berries the latter part of the season, and are then out of reach of the common insecticides, but when feeding on the foliage they can be destroyed by dusting air-slacked lime over the plants when still wet with dew. The beetles can be poisoned upon the foliage with Paris green or arsenate of lead. If the insects are very abundant during the cutting season, it may pay to allow portions of the field to grow up and serve as lures to attract the beetles from the young shoots, where they may be poisoned.

Galerucella luteola (Müller).

The Elm-Leaf Beetle in Albany and Troy.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

Additional Bibliography to that contained in the Fifth Report on the Insects of New York, 1889.

HULST: Bull. xlvi N. J. Agricul. Expt. Stat., 1888, p. 9 (mention, as *Galeruca xanthomelæna*).

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MARLATT: Circ. 8 2nd Ser., Divis. Entomol., U. S. Dept. Agricul., 1895, pp. 1–4, fig. 1 (general account); in Bull. 2 New Ser., Divis Entomol., U. S. Dept. Agricul., 1895, pp. 47–50, 58 (work in Washington).

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In the preceding Report, the observed progress was given of the elm-leaf beetle along the Hudson river from Newburg northward until it reached Albany in 1892, and its subsequent spread in a portion of the city. It is proposed in the present article, to present some additional observations made upon this insect, which, from its serious injuries to a favorite shade-tree, is exciting much interest.

This insect was very destructive the present year to the foliage of the English elms (*Ulmus campestris*) in both Albany and Troy. A second brood of the beetle was observed in 1895, but, owing to absence from town, it was impossible to make the continuous observations upon it desirable. The present year an effort was made to settle some of the disputed points concerning the habits of the insect so far north. Two annual broods were known to occur in the southern part of New Jersey, while, according to the observations of Dr. Smith in successive years, the insect was limited to a single brood at New Brunswick, in the northern part of the State. On this account it had been taken for granted that but a single brood would develop further north, and observations made by Dr. Howard in Connecticut in 1895, seemed to confirm this belief. It was, therefore quite a surprise when, beyond question, two well marked broods were observed by me in Albany in 1895, and a small third one the present year (1896). Instead of retiring in midsummer to hibernating quarters, there to remain until the following spring, as at New Brunswick, the beetles continued their feeding and oviposition so late in the season that larvæ were to be found so long as any leaves remained suitable for their food.

Broods in 1896, in Albany.

The larvæ of the first brood, those from eggs deposited by the over wintered beetles, were observed descending the trees for pupation on June 19th. On the 22nd a number of the pupæ were collected. The first beetles of this lot appeared the 30th, and by July 7th they had all transformed.

Most of the English elms in the vicinity of South Hawk street, Albany, were completely defoliated by the first brood. A close watch of this district was maintained throughout the remainder of the season. July 11th a cluster of eggs was found on the large lower leaves of one tree. Unfortunately the tops of the tall trees were so inaccessible as to make their close observation impracticable. It is probable that numbers of eggs were laid on the foliage of the higher branches during the month of July, as eggs were found from day to day on the rather fresh lower leaves at a time when the upper appeared to be in even better condition.

On South Hawk street, an English elm, which had been defoliated by the first brood, was throwing out a fresh crop of leaves July 30th. This recent growth was abundantly infested with both eggs and young larvæ. August 11th, eggs and larvæ were still abundant on this tree, although its foliage was almost entirely destroyed, while at its base many larvæ and a number of pupæ were seen. Two days later the pupæ were more abundant. August 21st this tree began to throw out a third crop of leaves, and most of the pupæ at its base had transformed. This new growth was but little injured, although a week later other trees in its vicinity were found to have been recently infested. These latter larvæ may have been portions of a third brood.

A striking example of the work of the second brood and the continued breeding of the insect until late in the autumn was observed on Washington avenue about three blocks above the Capitol. A number of English elms, which had been but slightly attacked last year and had suffered very little by the first brood the present year, were badly injured by the second. Many of the leaves were skeletonized in midsummer, and August 19th pupæ were lying abundantly around the trees. Pupæ continued to be found in large numbers until after the middle of September, and in lessening numbers until November 1st. Larvæ were to be found as late as October 15th.

On Lancaster street, near Lark, there are several English elms which had suffered little injury during the summer. Much to my surprise, hundreds of full grown larvæ were on the walk beneath the trees on October 12th. Their abundance so late in the season in such numbers render it quite probable that they belonged to the third brood, rather than that they were belated individuals of the second.

Observations in Troy.

The occurrence of two, and probably of three, broods was even more conclusively shown by the observations made at Troy, N. Y. On Eagle street in that city, there is a row of small English elms, which when first visited on August 18th presented a sad sight. Every leaf had been skeletonized, and there were only the dried remains of what had been a luxuriant foliage. In other parts of the city the trees had given out new leaves, which were badly infested with eggs. Eleven days later, the new leafage on Eagle street was already badly infested with eggs and recently hatched larvæ. Four egg clusters were counted on a small twig bearing but five leaves. September 9th there were many young larvæ and a few nearly full-grown, and numerous egg clusters — on a

single leaf there were six. A week later the new foliage had suffered severely. Four or five larvæ were commonly found on a small leaf. Most of them were about half-grown, and a few were full-grown. September 25th many larvæ and a few pupæ were found on the trunks of the trees. A number of half-grown larvæ and some beetles were feeding on the leaves. October 1st a few larvæ were feeding; full-grown ones and numbers of pupæ were seen on the trunks and at the base of the trees, and beetles were feeding on the leaves. On the 22d of October several young larvæ were seen on a bunch of the greenest leaves, and near them a cluster of egg shells from which they had probably emerged within a few days. October 31st several full grown larvæ and a pupa were found at the base of one tree, and also a beetle just completing its transformations. On one tree with exceptionally green leaves, a number of very small larvæ were seen, and near them a cluster of egg shells. At this time most of the English elms were leafless. One week later, November 7th (the last observation for the season), a few pupæ were still to be found, which transformed successfully to beetles. The above facts indicate most clearly that the beetles would continue reproduction so long as there was suitable food. It also seems reasonable to refer the latest larvæ and pupæ to a limited third brood, rather than to the progeny of belated individuals of the second brood.

Notes on Oviposition and Transformations.

In connection with observations of the beetle in nature, breeding experiments were also attempted. Owing to the difficulty of obtaining new leaves for the larvæ, they were not so successful as could be desired.

On the 6th of July a large number of recently transformed beetles were confined with fresh, though old, elm leaves. They fed so voraciously that a new supply was furnished them every two or three days; especial care was taken to introduce no eggs with the food. Egg clusters were found as follows: 1 on the 8th; 4 on the 11th; 1 on the 13th; 3 on the 14th; 2 on the 16th; 15 on the 18th; 9 on the 21st; 3 on the 23rd; and 2 on the 25th,— the oviposition having extended over seventeen days. Most of the eggs were deposited in normal clusters and were fertile, although the conditions in the cage were not quite normal. From the above data it would appear that in summer most of the eggs are laid 12 to 14 days after the perfect form is assumed.

At this time tender leaves could not be obtained, and the young larvæ, under the ordeal of their confinement, perished a few days after emerging

from the eggs. Some recently hatched larvæ were found on a tree July 30th, and were successfully reared to the pupa — one assuming that form August 11th and others a few days later. Young larvæ taken on a tree September 9th, pupated October 7th. The eggs and larvæ of this insect on a leaf are represented in figure 1 of plate VIII,—in the lower left-hand corner an egg cluster is shown enlarged.

The duration of the egg stage in July averaged about 5 days, that of the larva 15 to 20 days, and of the pupa 7 days. In the autumn, as might be expected, these periods are considerably prolonged by the colder weather. In September, the pupa stage was observed to last 12 days, and in October twice as long.

The duration of the beetle's existence is also of interest since it has a bearing on the probability of the occurrence of a third brood. A record of the mortality of those confined in a cage July 6th (see above) was kept, which is as follows: 7 dead the 16th; 4 the 18th; 5 the 21st; 2 the 23rd; 15 the 25th. Most of those that died the 23rd or before were badly affected with a fungus, *Sporotrichum entomophilum* Peck, and many of them may have been killed by it. The death of the others may have been hastened by the unnatural conditions of confinement. As but few of the beetles died before most of the eggs had been laid, it is probable that they live but a short time after having provided for the perpetuity of the species.

Although eggs and larvæ were not obtained from individuals known to belong to the second brood, yet the rearing to the pupa and imago stages, of those collected abroad as cited above, show conclusively that there was ample time for three generations during the activity of the insect. The beetles were seen feeding the latter part of August, during September, and even into October, and eggs, or evidences of recent oviposition, existed throughout the time. The limited life of the beetles after oviposition observed in July, renders it most probable that the same was true later in the season. From the preceding, there is hardly room for doubt that there was a genuine third brood of the insect in Albany and Troy the present year.

Food-Habits of Larvæ and Beetles.

Some of the young larvæ obtained from eggs in July were fed with the greenest of the old leaves that could be obtained. Everyone of several lots died after a few days, and then it seemed as if they were unable to develop upon the old growth. August 11th, some half and some nearly full grown larvæ were placed on old leaves. They at once began feeding,

and eventually matured. The next day some recently hatched ones found on a tree were transferred to an old leaf, and a fair proportion of them completed their transformations. That the larvæ actually mature on old foliage is rendered certain by the development of a large second brood on a number of trees which had been scarcely injured by the first brood, and by the continued breeding of the insect on them until late in the autumn, as recorded before. A leaf skeletonized by the larvæ is shown in figure 4. Many trees had nearly every leaf as badly eaten as the one photographed.

The ravages of the second brood of beetles in Capitol Park on the American elms (*Ulmus Americana*) was much more marked than of the one earlier in the season. One tree was nearly defoliated, and large portions of adjacent ones. The injury to American elms in other parts of the city was comparatively slight, so far as observed, although they were in close proximity to badly infested English elms.

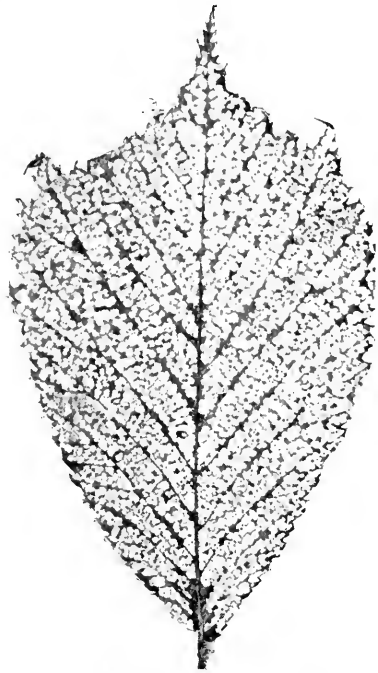

FIG. 4.— Work of elm-leaf beetle larvæ.

The larvæ, under certain circumstances, may play the part of cannibals. In one instance, when food had not been given them in three days and all the leaves had been eaten, — upon opening the box containing them, a larva was seen devouring a living pupa: it had already eaten away a large portion of the dorsal wall of its thorax.

The beetles, as before noted, are ravenous feeders before oviposition— commonly eating large holes in the leaves. In one case observed August 31st, they had been skeletonizing an old leaf in a manner very similar to that of the young larvæ. The leaf was unusually dry and somewhat dusty, and its unpalatable condition may have been the cause of the departure from their ordinary feeding habit.

Spread of the Insect in Albany.

The area occupied in numbers by the first brood of the insect the present year corresponded quite closely with the thickly infested area of

1895. It would only be necessary to extend the lines indicated in 1895 a few blocks westward and northward to have the two areas coincident. The badly infested area in 1896 was the southern portion of the city bounded on the north by State street, on the west by Dove street, and on the south by Beaver Park. A limited infestation was noticed in the vicinity of North Hawk street and Clinton avenue.

The second and third broods materially extended the thickly infested area. The westward extension is to Lark street, but in Lancaster, reaching almost to Washington Park. The large second brood on the Washington avenue trees, hitherto practically free from the pest, defines the northwestern limit at the corner of Lark street and the avenue. The defoliation of trees in Capitol Park and on the streets lying off North Hawk street, indicates a northern extension of the insect which is virtually limited by Third street, and easterly and westerly by North Pearl and North Swan streets respectively.

The slow spread of the insect is in accordance with the partial migratory habit recorded by Dr. Riley, although signs of its presence in limited numbers are to be found over a much larger portion of the city than indicated above — practically the greater portion.

Ravages in Albany.

The ravages of this insect in Albany the present year were very severe. In the southern portion of the city, where the insect has been established for several years, almost every English and Scotch elm was defoliated at least once, and a number suffered the loss of their second leaves. The early part of the season, a number of fine trees had died and were removed. Apparently, it only requires three or four years of successive defoliation to kill the elms. A row of nine, on South Hawk street, formerly splendid specimens of the English elm, are nearly ruined and will probably die the coming season. The American elms were severely injured in some places, several having been nearly defoliated during the latter part of the summer. The injuries to this native species are on the increase, as is evidenced by the large number that have been attacked. It is safe to estimate that over two hundred fine elms in the southern residential portion of the city have already been killed by this pernicious pest. From present indications, it is only a question of time when the European elms will be destroyed and the American elms seriously injured, unless the insect be checked in its destructive course, by effective action of the citizens of Albany or its civic authorities.

Injuries in Troy and Vicinity.

The neighboring city of Troy, N. Y., six miles northward of Albany, was visited August 18th for the purpose of observing the operations of the elm-leaf beetle there and in the vicinity. It was found that the foliage of most of the English elms throughout the city had been completely skeletonized by the larvæ of the first brood. From the western end of Hyland avenue, commanding a view of a large portion of the city, the brown, dead leaves could be seen in all directions, and gave the impression of an extensive destruction by fire.

A closer examination of the condition of the English and Scotch elms throughout the city, showed that the infestation and consequent damage was fully as great as appeared from a general view. The elms everywhere were seriously injured, and in most instances the first crop of leaves had been completely destroyed. It was learned that the insect had been in the lower part of the city for years past—at least three. From this it would appear that the beetles must have entered Troy in 1892, and possibly earlier. The city had certainly suffered more from the insect the past year than had Albany.

The most badly infested region in Troy was between the Hudson river on the East and Fifteenth street on the West, extending from near the southern boundary of the city to Hoosick street on the north. The southern end of Green Island and, on the western bank of the river, a large portion of the city of Watervliet (formerly West Troy), was also badly infested. The insect was found in limited numbers on the high lands east of Troy, along Tibbets avenue, at Albia, and at Averill Park in the town of Sand Lake, some seven miles southeast of the city. On the north and west of Troy, signs of it in limited numbers were seen over most of adjoining Lansingburg, and in portions of Cohoes and Waterford on the opposite side of the river. It had become established at Menands, half way between Albany and Troy, in considerable numbers. It had also been found by Dr. L. O. Howard, Entomologist to the U. S. Department of Agriculture, at Mechanicville, about ten miles north of Troy.

Associated Insects.

The elm-leaf beetle finds a very efficient ally in its destructive work in the European Coccid, *Gossyparia ulmi* (Geoff.), which is widely distributed over Albany, Troy and Watervliet. The insect was so numerous on many trees that the leaves and branches were blackened by the fungus growing in its abundant secretion to such an extent as to render them conspicuous at a distance. Its occurrence in such numbers must weaken

the trees to a considerable extent in the course of time. For a more extended notice of this insect see subsequent pages of this report (XII).

The injured and dying elms were also attacked by the pigeon Tremex, *Tremex columba* (Linn.), in numbers both in Albany and Troy. Many of the trees showed numerous large holes made by the Tremex larvæ. On the trunk of one small tree, two dead females were held by their inserted ovipositors, and, at the base of the tree, the remains of four others were found. The parasites of the Tremex were also active. One female of *Thalessa lunator* (Fabr.), "the lunate long-sting," was taken while ovipositing in the trunk of an infested tree. The remains of thirteen ovipositors securely fastened in the trunk of one small infested tree were eloquent testimonials to the activity of Thalessa in its search for the Tremex larvæ.

Natural Enemies.

The elm-leaf beetle has so few natural enemies that they do not appear to thin its ranks materially. A number of dipterous maggots were found among a mass of larvæ and pupæ collected at the base of a tree. There was no evidence that they attacked the living forms, yet more occurred than one would naturally suppose could find sustenance in the small amount of decaying matter present. Unfortunately they were not brought to maturity, and the species could not be determined.

Podisus spinosus (Dallas) was detected with a half-grown larva of the elm-leaf beetle on its extended beak, and it was also reported from Poughkeepsie as preying on the insect. A larva of a lace-wing fly, *Chrysopa*, was found in the vicinity of some dead larvæ of the elm-leaf beetle, and it was thought that possibly this was another of its predaceous enemies. A mite was noticed near some injured eggs, but it escaped before its identity could be established or its relation to the mischief ascertained.

Many of the beetles were killed by a fungus. It affected numbers of them in the breeding cages, and on some trees clusters of beetles would be found filled with it. Examples were submitted to State Botanist Peck, who has described the fungus as a new species in his report for 1896 under the name of *Sporotrichum entomophilum*. Like the disease affecting the chinch bug, caused by *S. globuliferum* Speg., that of the elm-leaf beetle can not develop rapidly in the absence of moisture. The affected beetles were found only where there was abundant moisture, as for example, in damp crevices in the trunks of the trees, in masses on damp ground and in moist breeding cages. The necessity of moisture to the development of *Sporotrichum entomophilum* Peck, renders the disease of doubtful value as a check on the undue increase of the elm-leaf beetle.

Remedies.

The proper and most satisfactory method of dealing with this insect is by spraying with the arsenites (one pound Paris green to 200 gallons of water) when the recently hatched larvæ are beginning to feed, as has been frequently pointed out before. Unfortunately for the general adoption of this means, the machinery necessary for spraying large trees is so expensive as to place it beyond the reach of many. Where a large number of the shade trees in a city are to be treated, some form of a steam apparatus for spraying appears to do the work with the greatest efficiency and economy. Although the machinery may be expensive, the cost of spraying per tree is by no means large. The abundance of the elm-leaf beetle in various cities has forced the authorities to resort to efficient means for protecting the trees. The cities of New Haven, Conn.; Springfield and Holyoke, Mass.; and Brooklyn, N. Y., have had constructed various successful forms of steam sprayers. Some difficulty was experienced in using the machines in these cities, either on account of their large size or the noise made by them while in operation. In New Haven it was found necessary to close the street during the spraying to avoid frightening the horses. Among the best of these may be mentioned the spraying apparatus constructed under the supervision of Dr. E. B. Southwick for the department of public parks of the city of New York. It consists of a "Diamler" gasolene motor connected with a three-piston Gould pump, the latter the smallest size of that pattern. The motor and the pump weigh about 300 pounds. The whole can be placed in a spring wagon with a 100 gallon, or larger, tank. The motor costs $250, and the pump about $50. The machine can be operated at the cost of but a few cents a day and makes so little noise when running as to scarcely attract the attention of passing horses. This apparatus will probably be found much more satisfactory than any makeshift, although it involves a greater outlay at first. For description of this apparatus, see the excellent paper by Dr. L. O. Howard on "The use of steam apparatus for spraying," in the Year Book of the U. S. Department of Agriculture for 1896, pages 69 to 88, from which the preceding has been taken.

There are now, and probably will be, a number of cities and large villages where this pest is prosecuting its destructive work, and where those in authority will not take the steps necessary for protection against it. In such localities there is an opportunity for some enterprising individual to fit up the proper apparatus and contract with property owners for spraying their trees either at so much a tree, or at so much for the season.

This has been done already in some places. At Bridgeport, Conn., Mr. W. S. Bullard has engaged in such work for the past few years. The firm of H. L. Frost & Co., 21 South Market St., Boston, Mass., is making a speciality of all kinds of spraying and of pruning trees. The members of this firm are graduates of the Massachusetts Agricultural College and deserve encouragement in this comparatively new line of work. Where no provision has been made for spraying, or where it has been carelessly done, the larvæ and pupæ that may be found on the trunk and at the base of the tree should be destroyed with hot water or kerosene emulsion. Many of the insects can be killed in this manner, but only after they have ceased feeding. This measure simply reduces the number of the insects of later broods. It may be made more effective by scraping the rough outer bark from the lower limbs and the trunk of the tree so that a larger proportion would be compelled to descend to the ground in search of a hiding place while transforming instead of pupating within the crevices of the bark. A rude inclosure or box around the base of the tree would also be of service, as it would keep the larvæ from straying where they could not be so easily reached and killed.

Odontota dorsalis Thunb.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

———— *dorsalis* THUNBERG: Götting. Gel. Ang., 1805, p. 282.

Chrysomela scutellaris OLIVIER: Ent. Hist. Nat.— Coleopt., vi, 1808, p. 771, Pl. 2, fig. 21.

Hispa suturalis HARRIS: in Bost. Journ. Nat. Hist., i, 1835, p. 147 (pupa [Fig. 2] and imago described); Ins. Inj. Veg., 3rd Edit., 1862, p. 121 (description).

Anoplitis scutellaris. FITCH: 5th Rept. Ins N. Y., 1859, p. 54 (brief notice of larva and imago); the same in Trans. N. Y. State Agricul. Soc for 1858, xviii. 1859, p. 834; in Country Gent., xxvi, 1865, p. 190 (ravages on Long Island).

Hispa suturalis. PACKARD: Guide Study Ins., 1869, p. 504 (mention).

Odontota scutellaris. RILEY: in Amer. Entomol., iii, 1880, p. 151 (on *Robinia* and *Quercus alba*).

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Odontota dorsalis. HORN: in Trans. Amer. Entomolog. Soc., x, 1883, pp. 296, 303 (description and synonymy).

Odontota scutellaris. DIMMOCK: in Kingsley's Stand. Nat. Hist., 1884, p. 315 (not confined to the locust).

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Odontota suturalis. HOWARD: in Entomolog. Amer., i, 1885, p. 117 (two parasites described).

Odontota scutellaris. PACKARD: 5th Rept. U. S. Entomolog. Comm., 1890, p. 367 (in New England).
Odontota dorsalis. HOPKINS: Bull. 16 W. Va. Agricul. Expt. Stat., 1891, p. 87, Pl. 13, fig. 1, *a-d*; in Canad. Entomol., xxviii, 1896, p. 248 (food-plants, destructive in W. Va).
Odontota suturalis. LINTNER: 10th Rept. Ins. N. Y., 1895, p. 369 (parasitized by *Derostenus*).
Odontota dorsalis. LINTNER: 11th Rept. Ins. N. Y., 1896, p. 269 (on apple).
Odontota dorsalis. BLATCHLEY: in Psyche, vii, 1896, p. 437 (in Indiana).
Odontota dorsalis. CHITTENDEN: in Bull. 9 New Ser., Divis. Entomol., U. S. Dept. Agricul, 1897, pp. 22–23 (herbaceous food-plants).
Odontota dorsalis. WEBSTER: in Bull. 74 Ohio Agricul. Expt. Stat., 1897, p. 35 (abundance in Ohio and Kentucky).
Odontota dorsalis. WICKHAM: in Canad. Entomol., xxix, 1897, p. 60, fig. 10 (in Canada).

This insect, although quite abundant at times in certain localities, had not occurred in the collections made by me in Albany and Schoharie counties, or in occasional collecting in other portions of the State. From the abundance with which it is reported below, upon the locust, it may have been overlooked by me in my limited examinations of the insect fauna of that food-plant. Dr. Fitch, writing in 1858, stated that he had never met with it in the eastern part of the State, although common in the southern.

The Insect on Long Island.

Examples were received by me on August 31, from Dr. Harrison G. Dyar, which had just been taken by him from locust trees (*Robinia*) at Yaphank, L. I. The leaves had been eaten (Pl. VIII, fig. 2) until they bore the appearance of elm leaves attacked by the elm-leaf beetle, and as the result of the severe injury, the foliage was rapidly falling.

In a re-examination of the trees by Dr. Dyar a week later — a roadside row of about twenty in number and patches of locust shrubs in a woods opposite — all the remaining foliage had turned brown. To the east and the west of this locality only a slight injury was noticeable, while to the northward, in another row of locusts between two fields, the leaves were still green and apparently uninjured.

In West Virginia.

Dr. A. D. Hopkins has written on the abundance and injuries of this Chrysomelid as observed by him in 1890, at Morgantown, W. Va., and its vicinity. In his bulletin on "Insect Ravages — Yellow Locust" (*sup. cit.*), he has stated as follows:

"This beetle was extremely plentiful on the locust leaves at the time the investigation was being made (early August), — as many as eight or

ten were frequently found on a single leaf. They probably appear in May or June, when they deposit their eggs on the under side of the leaves, which hatch into small grubs that burrow into the leaves and feed upon the substance beneath the surface, forming blisters near the edges which usually extend to the midrib. * * * They change within the blister to the pupa form, from which the beetles soon emerge and feed on the surface of the remaining unaffected leaves. The blisters formed by the larvæ and the leaves skeletonized by the beetles, * * * cause the leaves to turn brown, wither and fall. * * * The beetle was also taken feeding on the leaves of the locust at Morgantown, on June 10th, and at Kanawha Station on June 16th.

"Like the plum curculio, it is the habit of this beetle to fall to the ground when alarmed, and in the case of valued shade trees, it may be possible to destroy them by the jarring process which is successful with the curculio. Their habit of feeding on the upper surface of the leaves would make it easy to treat them by spraying the trees with poisoned liquid."

Food Plants.

Although the locust is the natural food-plant of this insect, it seems not to be entirely confined to it, for Dr. Dimmock has reported it as extending its devastation to a number of other trees.

A correspondent of the American Entomologist (Vol. iii, p. 151), represents it as devouring the advanced foliage of Siberian crab-apples in the first week of May, and "in the wild woods, the tender leaves of *Ulmus Americana*." Finding insufficient food in the mined *Robinia* leaves, they attack the young leaves of red-oak (*Quercus rubra*), leaving other species of oaks near by, untouched. Mr. Hopkins (*loc. cit.*) found the insect feeding on the foliage of white oak, beech, birch and hawthorn in West Virginia, and Mr. Chittenden (*l. c.*) records instances of their feeding on red clover, hog peanut (*Falcata comosa* which is the *Amphicarpæa monoica* of Gray's Manual) and soja beans.

Dr. Harris' Account of the Insect.

According to Dr. Harris, the beetles may be found pairing in Massachusetts, in the middle of June and laying eggs on the leaves of the locust trees which are transformed to the perfect insect in August. "They measure nearly one-quarter of an inch in length, and are of a tawny yellow color, with a black longitudinal line on the middle of the back, partly on one and partly on the other wing-cover, the inner edges of which meet together and form what is called the suture; whence the species was named *Hispa suturalis* by Fabricius; the head, antennæ,

body beneath, and legs are black; and the wing-covers are not so square behind as in the rosy Hispa." (Pl. VIII, fig. 3.)

The Larva.

The larva has been briefly characterized by Dr. Fitch as — "a small, flattened, whitish worm, attaining a quarter of an inch in length, tapering from before backwards, with projections along each side like the teeth of a saw, and with only three pairs of feet, which are placed on its breast; eating the parenchyma and leaving the skin of the leaf entire."

Parasites.

Several species belonging to the large parasitic family of *Chalcididæ* have been reared from this insect by Dr. Riley, and described at his request by Dr. Howard. *Spilochalcis* [*Smicra*] *odontotæ* Howard, was reared from the pupa of this locust feeder. *Sympiezus uroplatæ* Howard feeds externally on the larva within its mine. *Trichogramma odontotæ* Howard, is an egg parasite issuing in July. *Derostenus primus* Howard MS., was reared from the leaf mine of *Odontota*. Dr. Howard thinks it may be a secondary parasite, preying upon either of the first two species (*loc. cit*).

Distribution.

Dr. Horn has given the distribution of this insect as, "Middle and Southern States." Dr. Packard records it from New England, Middle and Western States. Prof. Webster has mentioned defoliations by it (more or less complete) in southern Ohio and adjacent parts of Kentucky.

Balaninus proboscideus (Fabr.): **Balaninus rectus** Say.

The Chestnut Weevils.

(Ord. COLEOPTERA: Fam. CURCULIONIDÆ.)

FABRICIUS: Ent. Syst. em., tom. i, pars ii, 1792, p. 440, No. 193 (description, as *Curculio proboscideus*).

SAY: Descript. N. Amer. Curculionides, 1831, p. 16; Compl. Writ., LeCont. Ed., i, 1883, p. 279 (original description of *Balaninus rectus*).

GLOVER: in Rept. U. S. Dept. Agricul. for 1870, 1871, p. 70, fig. 13 (*B. rectus* injuring chestnuts, life-history in brief).

PACKARD: 2nd Ann. Rept. Ins. Mass., 1872, p. 17, figs. 10, 11 (weevils in chestnuts); 5th Rept. U. S. Entomolog. Comm., 1890, pp. 215–216, fig. 69 (*B. rectus* in acorns), pp. 350–352, fig. 132 (brief account of *B. caryatrypes* [*proboscideus*] in chestnuts), p. 354 (*B. rectus* in chestnuts).

RILEY: in Canad. Entomol., iv, 1872, p. 19 (*B. uniformis* erroneously referred to *B. rectus*); 4th Rept. Ins. Mo., 1872, p. 144 (injury, life-history in brief of *B. rectus*, probably *B. uniformis*)

HORN: in Proc. Amer. Philosoph. Soc., xiii, 1873, pp. 457, 458, 459 (describes *B. caryatrypes* and *B. rectus*, table of species).

BLANCHARD: in Bull. Brook. Entomol. Soc., vii, 1884, p. 107 (table of species; *B. caryatrypes*, *rectus* and others).

HAMILTON: in Canad. Entomol., xxii, 1890, pp. 1–3, 7 (habits, distribution, parasites of *B. caryatrypes* [referred to *B. proboscideus*] and *B. rectus*); in Insect Life, iv, 1891, p. 130 (*B. proboscideus* and *B. rectus* commonly infesting chestnuts and chinquapins) p. 131 (larval habits of *B. proboscideus*).

LINTNER: 7th Rept. Ins. N. Y., 1891, p. 383 (mention); in Country Gentleman, lix, 1894, p. 504 (brief mention); 10th Rept. Ins. N. Y., 1895, pp. 501, 517 (mention, all referred to *B. caryatrypes*).

RILEY-HOWARD: in Insect Life, iv, 1891, p. 93 (*B. proboscideus* and *B. rectus* reared from chestnuts and chinquapins, notes on habits).

MCCARTHY: in Bull. 105 N. C. Agricul. Expt. Stat., 1894, pp. 267–272, fig. 1 (injuries by chestnut weevils, general account of *B. proboscideus*).

SMITH: in Rept. N. J. Agricul. Expt. Stat. for 1893, 1894, pp. 481–485 (general account of *B. proboscideus* and *B. rectus*); Econom. Entomol., 1896, p. 236. fig. 243 (*B. rectus* figured).

COMSTOCKS: Manual Study Ins., 1895, p. 593 (*B. caryatrypes* and *B., rectus* mentioned).

SARGENT: in Gard. Forest, viii, 1895, p. 8 (brief account after Smith).

"Wormy chestnuts" are familiar to all lovers of this favorite nut, although few can recognize the parent weevil of these unwelcome grubs. In some seasons the chestnuts are so seriously infested that a large proportion of the crop is rendered worthless by their attack. It not infrequently happens that a lot of chestnuts are stored in some box or vessel soon after gathering and are found a few weeks later badly infested and sometimes almost destroyed by the white grubs or larvæ of these weevils.

Chestnuts as a Market Crop.

The growing of these nuts for market is an industry that is yet in its infancy in this country, but it is one of considerable extent and may be expected to develop to a much greater degree in the future. There are many acres in this and other States now almost unproductive, which are capable of producing large crops of the nut at a slight expense. Great quantities of Spanish nuts are imported from year to year, although equally good, if not better, ones can be grown here. As an instance of what has been done along this line — the twenty acres of bearing Paragon chestnut trees of Mr. H. M. Engle, Marietta, Pa., may be mentioned. Native trees were cut on a steep hillside and the sprouts grafted to

this improved variety,— the grafts beginning to bear when about three years old. The trees were kept properly trimmed and the ground clear from underbrush. The land now yields more in value than an equal area of potatoes and at a much less expense. The improved varieties being easily grafted on native stock, makes it easy to transform in a few years comparatively worthless trees to valuable fruit producers. The most serious drawbacks are the underbrush, injury by insects, and thieves.

Extent of Injury by Chestnut Weevils.

The amount of injury by these insects varies much both with the season and the locality. Mr. R. C. Hewson, Penn Yan, N. Y., estimates the annual loss of native nuts in that vicinity at from five to ten per cent of the crop. This appears to be rather a conservative estimate, since in Massachusetts as high as forty per cent of the chestnuts in certain seasons are injured by these weevils. Sometimes in New Jersey fifty per cent of the Japanese and Spanish varieties are ruined, and Dr. Smith cites an instance in which the crop was almost entirely destroyed at the Parry Brothers nursery. The loss in Maryland ranges from ten to twenty-five per cent, in Delaware from thirty to forty, and in North Carolina from ten to fifty—possibly averaging, about twenty per cent. From five to twenty-five per cent of the few native nuts in Michigan are injured by the weevils.

The Genus Balaninus,

This genus is remarkable among the *Curculionidæ* or snout beetles for the unusually long proboscis or snout, — it being rarely shorter than the body, and in the female it is frequently twice the length. The members of this genus feed in the larval state on chestnuts, walnuts, hickory nuts and hazelnuts — all having thick husks and hence necessitating a very long beak for the purpose of perforating to the kernel that the eggs may be deposited near a suitable food supply. The extremely long beak may well be regarded as a special adaption to the requirements of the existence of this genus. It also differs from the other *Curculionidæ*, and in fact from all other known Coleoptera, by having the mandibles vertical instead of horizontal. The structure of this form is so different from its allies that it has been raised to sub-family rank (LeConte-Horn: *Rhynchophora of America*, 1876, p. 322).

Two Species Attacking Chestnuts.

There are at least two species that injure chestnuts in this country. The great chestnut weevil, *Balaninus proboscideus* (Fabr.), formerly known as *B. caryatrypes* Bohm., is the larger. This form may be separated from the

other American species of this genus by the first joint of the antenna being shorter than the second. It is beautifully variegated with fuscous lines and spots interspersed among the dense clothing of ochreous scales on the thorax and wing-covers. Some examples are entirely ochreous. The beak of the female varies in length from one and one-fourth to twice the length of the body. Its distribution has been given as follows: Massachusetts, New Jersey, Pennsylvania, District of Columbia, North Carolina, West Virginia, Ohio, Illinois, Tennessee, Middle States westward. Other localities are recorded by McCarthy for chestnut weevils, but the species are not indicated. The smaller chestnut weevil, *Balaninus rectus* Say, has a wider recorded distribution, as follows: Canada, Massachusetts, New York, New Jersey, Pennsylvania, District of Columbia, Virginia, West Virginia, Ohio, Southern States and Arizona. Besides the above, chestnut weevils have been reported from Delaware, Maryland, Georgia, Michigan and Missouri, but without having been referred to either species. Possibly each of the species may have a distribution over the United States co-extensive with its chosen food.

B. rectus varies in size from about one-sixth to one-third of an inch in length. The general color of the scales and hair is light brown above, paler below; on the thorax there is a dark brown discal stripe, which is limited at the sides and divided longitudinally by a pale yellow line. The elytra are variously marked with the same color. The beak of the female is very long, being equal to or even longer in proportion than in *B. proboscideus*. The long beak and the long conical thorax is said to distinguish *B. rectus* from the other species of the genus. The male is not so easily recognized: "It has a shorter thorax, but it is still narrowed anteriorly; this, with small femoral tooth, oval elytra rapidly narrowed from base, and a yellowish or brownish spot of condensed scales on each side of the central line of the metasternum (occasionally obsolete), will, with practice, distinguish it." (Hamilton.) (See Pl. VIII, figs. 4, 6.)

Life-History.

The life-history of these two species agrees quite closely, so far as known. The weevils of *B. proboscideus* appear about the time of the blossoming of the chestnut trees, — this being variable in the different latitudes, and oviposit in the young burrs. The long beak of the female is used to pierce the husk to the kernel, and one or more eggs are then deposited therein. The slight injury done the burr and the nut at this early period of its development soon heals and shows no indication of the grub within as it comes to maturity. The holes noticed in "wormy

chestnuts" are made for the exit of the larva (Pl. VIII, fig. 5). The female lives but a short time, — a week or two at the most. All of the larvæ of this species enter the ground in the autumn, none wintering in the nuts although thought probable by some writers.

The adults of *B. rectus* appear also about the time of the blossoming of the chestnuts. When rearing this species, Dr. Hamilton found that its appearance in the breeding cage was much more irregular than was that of the preceding, — varying from June 28 to October 1. On the latter date, there were in the cage pupæ in various stages and many larvæ that would doubtless live over the approaching winter. A delay until the second season is quite common in this species and is one of nature's safeguards against extermination should there be an entire failure of the crop in any one year, as happens occasionally. The preceding species has been reared only from chestnuts, while *B. rectus* is known to breed also in chinquapin nuts and acorns. This diversity of food habit in *B. rectus* may account in part for the marked irregularity of the appearance of the weevils. There appears to be no record of *B. proboscideus* remaining over until the second year in the pupa state, although it is probable that such instances occur. The method of oviposition of the smaller weevil appears to be practically the same as in the larger species.

Urosigalphus armatus Ashm., is the only known parasite of this genus, having been reared from all the species except *B. obtusus* Blanch.

Remedies and Preventives.

It would not be worth while to attempt to prevent oviposition in the growing nuts by poisoning the weevils, even if practicable, on account of the labor involved. Moreover, it has not been shown, as in the case of the related plum curculio, *Conotrachelus nenuphar*, that these weevils could be killed in this manner. Their short adult existence in comparison with that of the plum curculio would lead one to doubt the efficacy of any such measure.

The best methods of controlling these insects will be in preventive measures. All infested nuts should be destroyed each year before their occupants have had opportunity for leaving them and entering the ground for their transformations. When the nuts are not picked from the trees they should be gathered as soon as they fall and tested by turning them into a vessel of water, when, by brisk stirring, most of the wormy ones, being lighter than the liquid, will float to the surface and may easily be removed and destroyed. The others should be taken from the water and after drying, placed in a tight receptacle until shipped,

so that if there are still infested nuts, the grubs can not leave and enter the ground and continue their attack another year. A more thorough treatment would be to subject the nuts in a tight room or box to the fumes of carbon bisulphide for about twenty-four hours, using one pound of the carbon bisulphide in shallow vessels to each 1,000 cubic feet of space. Fire must be kept away from this chemical as its fumes are inflammable and explosive. The nuts will not be injured by this treatment.

Jarring the trees has been found very effectual with the plum curculio, and it should be of equal value against these weevils, while requiring fewer repetitions, owing to the shorter period of oviposition. By visiting the trees each morning and catching the weevils as they fall upon a broad sheet prepared for the purpose, for the short space of a week or two, the crop would be comparatively free from these pests. Oaks and wild chestnuts should be as remote from the cultivated ones as possible, that they may not serve the insects for breeding purposes.

Cicada septendecim Linn.

The Periodical Cicada.

(Ord. HEMIPTERA: Subord. HOMOPTERA: FAM. CICADIDÆ.)

Additional bibliography to that contained in the 2nd and 7th Reports on the Insects of New York.

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CAULFIELD: in 20th Ann. Rept. Entomolog. Soc. Ont., 1890, pp. 62–63, fig. 44 (brief account of habits; rare in Canada, not in Quebec).

RILEY; in Insect Life, iii, 1890, p. 87 (*Sphecius speciosus* destroying Cicadas); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, pp. 14, 19 (injuring apple and peach trees); in Proc. Entomolog. Soc. Wash., iii, 1893, pp. 115–118 (larval life of the 17 and 13-year Cicadas); in Insect Life, vi, 1894, p. 281 (reference).

LINTNER: 7th Rept. Ins. N. Y., 1891, pp. 296–301, fig. 24 (notice of appearance in 1890); 9th do., 1893, pp. 385, 440 (reference); The Periodical Cicada, or the Seventeen-year Locust: Issued as a circular of four pages, June 19, 1894 (reprinted in the following); 10th Rept. Ins. N. Y., 1895, pp. 420–425, figs. 14, 15 (brief account of brood XII in 1894), pp. 518, 519 (contributions to St. Coll.).

MOTTE: in Insect Life, iv, 1891, p. 141 (broods in Ohio).

COQUILLETT: in Bull. 27 Divis. Entomol., U. S. Dept. Agricul., 1892, p. 44 (reference).

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CHAMBLISS: Bull. i, Vol. vi, Univ. Tenn., Agricul. Expt. Stat., 1893, p. 6 (injuring roots of apple-trees).

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DAVIS, W. T.: in Proc. Nat. Sci. Assoc. St. Isl., iv, 1894, pp. 13–15 (appearance on St. Isl.); in Journ. N. Y. Entomolog. Soc., ii, 1894, pp. 38–39 (appearance of different broods), p. 96 (pupæ found); in id., iii, 1895, p. 143 (song and distribution).

GARMAN: in 6th Ann. Rept. Ky. Agricul. Expt. Stat. for 1893, 1894, p. 95 (mention).

KROM: in Scientif. Amer., lxxi, 1894, p. 295 (reason for Cicada chambers).

LANDER: in Scientif Amer., lxxi, 1894, pp. 233–234, fig., p. 327 (Cicada chambers); in Journ. N. Y. Entomolog. Soc., iii, 1895, pp. 33–38, Pl. II (Cicada chambers).

COMSTOCKS: Manual Study Insects, 1895, pp. 150–151 (brief notice).

LOVE: in Journ. N. Y. Microscop. Soc., xi, 1895, pp. 37–45, Pl. 49 (habits, stridulation and chambers).

SCHWARZ: Circular 22 2nd Ser., Divis. Entomol., U. S. Dept. Agricul., 1897, pp. 1–4 (distribution of broods expected in 1897).

SLINGERLAND: in Rural New Yorker, lvi, 1897, p. 437 (broods in Ohio, injuries).

The appearance of the periodical Cicada in any locality is of great popular interest on account of the number of years the insect spends in the larva or immature form under ground. The loud noise made by the adults and their occurrence usually in large numbers, brings them to the attention of even the most casual observer. The appearance of the insect is followed by a flood of local literature on its advent, and the many

stories of all kinds concerning it and its ways find ready credence among the people. Each return is also of interest to scientists as it gives, for a brief time, an opportunity for studying the ways of this singular insect. It is only by carefully observing their number as they appear from time to time, that an approximate idea can be obtained of the rate at which the insect is diminishing in number with its successive returns. Thanks to the studies of the late Dr. Riley, we know pretty closely the distribution of the different broods of the insect in this country and are able to foretell their appearance. The advent of the Hudson river valley brood in 1894 is of special interest to us, because it is the widest in range and the most numerous of any of the six or seven broods known to occur in the State of New York.

Characteristics of the Insect.

Most people have seen a Cicada (commonly known as a locust) and many have seen both pupæ and adults of the "periodical Cicada." The wingless, red-eyed pupa will be readily recognized with the aid of figure 2 of plate IX, and needs no further description. The perfect insect may easily be distinguished from the common dog-day Cicada or harvest-fly, *Cicada tibicen*, by the eyes and the veins of the wings being a bright red. More or less of the ventral surface of the abdomen (especially in the male) and the legs are of a dull red. The dorsal surface of the body is almost entirely black. If we compare the periodical Cicada with the dog-day Cicada or harvest-fly, we will find that the latter is a considerably stouter insect with green markings on the thorax, greenish eyes, and the veins of the wings bright green, while the ventral surface is more or less covered with a white powdery substance. The male and female of the periodical Cicada with their wings expanded, and one with its wings closed as in rest, are represented in figure 1 of plate IX.

Oviposition.

The female, when ready for oviposition, selects a small branch, preferably of oak or apple, but almost any tree except the pines, and placing herself near its tip she proceeds to deposit her eggs. With her ovipositor she saws a series of oblique holes in the twig with splintered outer edges, as represented in figure 5. In each she places from ten to twenty eggs, in pairs side by side, but separated from each other by portions of woody fibre, and inserted somewhat obliquely so that their ends point upward. A fissure is made and filled with eggs in from fifteen to forty minutes, when at a slight distance on the twig the operation is repeated.

The following account of the manner of oviposition of the Cicada is based on some interesting observations communicated to me in a letter by Mr. Ira H. Lawton, Superintendent of Schools at Nyack:

After finishing one fissure the female moved slowly forward about two steps, depressed her ovipositor about 45°, and setting her saws in motion, first alternately and then simultaneously, rapidly penetrated the bark, but the ovipositor was soon elevated to 25°. After penetrating to the full length of her ovipositor and filling that chamber with eggs, she swung a little to one side and through the same hole in the bark excavated the opposite chamber and filled it with eggs. The making of each chamber occupied a little over 20 minutes or a total of 45 minutes for the whole. During the cutting of a fissure, the saws made about 80 strokes to the minute, and after making four, the female would rest for a time. The head of the Cicadas was directed, in the main, from the tree but not invariably so, as some worked with their head toward the trunk of the tree.

FIG. 5.—Cicada punctures in twig.

Sometimes fifty of these fissures may be made by the same female in a twig, provided it is suitable to her needs. After depositing her complement of from 400 to 500 eggs, she drops exhausted from the branch and dies.

Natural History.

The time required for the hatching of the eggs has been variously stated at fifty-two days, forty-two days, and even so brief as fourteen days.

The newly hatched Cicadas are slender, grub-like creatures about one-sixteenth of an inch long (Fig. 6). They are as lively as ants, and after running about on the tree for a short time they drop to the ground where they bury. Their strong fore legs are admirably adapted for digging, and by their use they burrow in search of the tender, succulent rootlets into which they insert their beaks and extract their modicum of needed nourishment. The larvæ grow so slowly and require so little food, that they cause but slight injury to the trees or the shrubs to which they attach themselves. Ordinarily they remain at a moderate depth, especially during the earlier and later portions of their existence, though at times they have been found a number of feet below the surface.

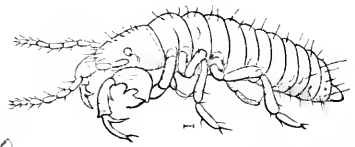

FIG. 6. Young Cicada, greatly enlarged.

Seventeen years, less the few weeks spent in the adult and egg states above ground, are passed by this insect in slow growth and development below the surface. There is but little change, except increase in size, in the appearance of the larva during this long period, but toward its close there may be noticed four scale-like appendages which represent the rudimentary wings. These have been gradually developed during the later stages of the larval existence. The emergence of the insect from its underground retreat, although separated by such a long period of years, is remarkably punctual, rarely varying more than a few days from the usual time. In the spring of the seventeenth year the larva makes its way, sometimes with great difficulty from obstacles encountered, to near the surface through a circuitous, smooth, and firmly compacted gallery, of a diameter barely sufficient to permit its passage. In its upper portion, at the proper time, it transforms to the pupa, which in turn forsakes the gallery just before it is ready to assume the perfect form and climbs the nearest tree or other support.* Here the pupa fixes itself firmly and awaits the time for the final change. The pupal shell (Pl. IX, fig. 2) soon splits along the back and the creamy-white adult with its red eyes and the black spots on the thorax works itself slowly out of the old case. It is soft just after emerging, and as it dries, the parts begin to harden and slowly to assume the colors natural to the perfect insect.

The cold weather that prevailed for the first week or two of their appearance, in 1894, resulted fatally to many, and large numbers of the dead might be seen lying upon the ground or clinging to the trees, — in the latter case often half-way out of the pupal shell. The adults live several weeks, feeding at will by means of their beak on the sap of trees. After pairing, oviposition occurs, and the long life-cycle of another brood is commenced.

A Thirteen-Year Brood.

In the Northern States of the Union this insect occupies seventeen years in completing its round of life as stated above, but in the Southern States, ranging as far north as southern Illinois, there is a form which requires but thirteen years for its transformations. It is to all appearances identical with the one occurring in the Northern States, except in a few minor details. The greater length of the growing season in the south may perhaps account for the quicker development of the larva. Dr. Riley was of the opinion that the thirteen-year form was but a race of *C. septendecim*, and not a distinct species.

* Under certain conditions the larva extends the gallery into an above-ground earthern chamber, which will be noticed hereafter.

It will here be opportune to refer to the attempt by Dr. Riley to determine by experiment, whether these two broods were really distinct species or only races. In 1885, eggs of the thirteen-year brood were sent to several places in the Northern States, and similar transfers of the eggs of the seventeen-year brood were made to the Southern States. The object of the transfer was to test the question whether the change from a warm latitude to a colder, and *vice versa*, would have any marked effect in retarding or hastening the life-period of the insect. Two lots of eggs of the thirteen-year brood were received by me in July from Dr. Riley and were placed in the apple orchard of Mr. Erastus Corning, at Kenwood, near Albany. The tree under which they were placed bears the following inscription on a zinc label:

"*Thirteen-year brood of Cicada (Riley's Brood, No. VII)—eggs from Oxford, Mississippi, planted July 4, 1885.*"

Additional eggs, together with the larvæ that had hatched while in transit, were placed under the same tree July 21. If any of the insects have lived and remain true to their period, their appearance may be expected in May or June, 1898. Should they fail to appear at that time, search will be made for them, if need be, for two or three successive years, and the results reported to the Entomological Division of the Department of Agriculture at Washington. Eggs of this same brood were also sent by Dr. Riley, to Ithaca, N. Y.; Boston, Mass.; Kittery Point and Brunswick, Me., and Ames, Iowa.

Distribution of the Hudson River Valley Brood.

Dr. Fitch, in 1856, gives as the limits of this brood, the valley of the Hudson river, from the vicinity of Schuylerville and Fort Miller* on the north, southward along both sides of the Hudson to its mouth, where it extends northeastwardly, at least to New Haven in Connecticut, and southward across the northern part of New Jersey and into Pennsylvania. Later observations enabled Dr. Riley to extend the limits of this brood,—including the greater part of the State of New Jersey most probably; localities in Fairfax, Albemarle, Campbell, and Fulvanna counties, Virginia; Charles county, Maryland, and the District of Columbia.

Observations and reports upon the occurrence of this brood in 1894 enable us to give the following as its distribution so far as known:

In New York the brood was reported from the Rural cemetery four miles north of Albany, and thence southward in localities on both sides of the Hudson river to New York City; at New Brighton,

* Forty-seven miles north of Albany.

Staten Island, in millions, and also in abundance at Bay Ridge, Flushing, and Queens, on Long Island. The occurrence of the brood along the Hudson may be briefly indicated by the following notes: New York county, abundant in certain localities in Woodlawn cemetery; Westchester county, in great numbers north to Croton; Rockland county, abundant at Palisades-on-the-Hudson, millions at Nyack; Orange county, millions at Highland Falls, West Point, Cornwall-on-Hudson, New Windsor, Newburg, and Middletown; Dutchess county, very abundant at Beekman, Poughkeepsie, Johnsville, Bangall, Annandale, Rhinebeck, Rock City, Redhook, Pine Plains, and Barrytown; Ulster county, abundant at Wallkill, millions at Marlboro, and large numbers at Milton, some at New Paltz, a few at Saugerties, abundant at Quarryville; Columbia county, very abundant at Clermont, and Claverack, millions at Hillsdale, reported from Livingston and Stuyvesant; Greene county, many at Catskill, very abundant at Athens and New Baltimore; Rensselaer county, abundant at Bath-on-Hudson; Albany county, swarms at New Scotland, many found at Voorheesville, large numbers at Bethlehem Center, some at Kenwood, abundant near Clarksville, and in the Albany Rural cemetery at Menands.

It will be seen from the above given data that the Cicada was quite numerous in localities near the river up to Putnam county. In Orange county they were reported very numerous at Middletown, twenty miles back from the river, and also at several places nearer the Hudson, showing that this is one of the strongholds of this brood. There was no report from Putnam county and they were probably not abundant there. The northern portion of Dutchess county is another stronghold of the brood, as they were found in numbers extending back nearly fifteen miles from the river. In the southern portion of Ulster county the Cicadas were in large numbers at Wallkill, ten miles from the Hudson, and at other places nearer the stream. The insect was found in force in the southern portion of Columbia county, at Hillsdale at a point about ten miles from the Hudson. In Greene county it was not observed far from the river. It was abundant on the Forbes Manor grounds at Bath on-Hudson in Rensselaer county, and in Albany county it occurred in a number of places, but plentifully in only a few. So far as known it was not seen north of Troy.*

In New England it was reported from localities in the vicinity of New Haven, Southington, New Britain, Farmington and Winsted, Connecticut, thus extending its range north nearly across the State to the Massachusetts line.

* It doubtless occurred north of this locality but no account of its presence was received.

In New Jersey they were observed in every county in the state, according to Dr. Smith, although it was only in the eastern portion that they were abundant. They were the most generally distributed in Bergen, Hudson, Essex, Union and Morris counties. From Pennsylvania reports of its presence were received from Tunkhannock and Blue Mountain.

Distribution of the variety Cassinii.

In response to the inquiry instituted by me in a circular distributed in June, 1894 (republished in my 10th Report, pp. 420–425) of the occurrence of the above-named variety, a few replies only were returned, their small number doubtless not indicating the absence of the variety, but more probably their non-recognition by the ordinary observer. None were observed at Nyack, Bangall or Hillsdale. A few were seen by Mr. Livingston at Clermont, and at Clarksville, Mr. Bagley reported about an equal number — *Cassinii* being rather the more numerous.

Time of Appearance and Continuance of the Brood.

The regularity of the time of the appearance and disappearance of this insect is remarkable when its long term of life is considered.* Both in this and in the adjoining states of Connecticut and New Jersey, it was quite true to its appointed time — the first examples of the perfect insect being seen the week following the 20th of May.† The peculiar cry of the male which has been often described, was first heard late in May in some places, and in others not until June 15th, and continued until July 1st in some localities, and in others until the 16th, from individuals which were the last to mature. None were reported as having been seen after the 20th of July. Thus the entire time during which living adults were to be found hardly exceeded two months.

Pupæ were first seen by Miss Emily Morton, of New Windsor, in the early part of March and during April as they dug their way through the soil of a green-house on the heights of Storm-Kill mountain.

The Cicada Chambers.

The interest aroused by the advent of this brood was greatly augmented by the discovery of a number of places in this State of their peculiar clay

* As an exception to this marked regularity, Dr. Riley has stated: "The Periodical Cicada frequently appears in small numbers, and more rarely in large numbers, a year before or a year after its proper period."

† The actual time of appearance is governed to a certain extent, not only by temperature, but largely by the character and condition of the soil. At New Haven it was observed that they issued earliest on the rocky heights where there were but a few inches of stony soil, and the latest to appear came from the moist ground of a fruit garden.

mounds built as an extension to the underground burrow (Pls. X, XI). Only two other instances of their occurrence prior to this have been given by writers, to be noted hereafter, and but one example was known in any collection — in that of the National museum at Washington, deposited there over twenty-five years ago.

The distribution of these above-ground chambers and the causes leading the larvæ to construct them, can not be satisfactorily explained. Their occurrence under widely different conditions, and the theories advanced to account for their building, renders it desirable that their localities be given so far as known.

Their Abundant Occurrence in New York.

To Benjamin Lander, of Nyack, N. Y., belongs the credit of having discovered and studied on South Mountain, near Nyack, by far the largest tract of ground thickly dotted with these chambers that had ever been observed. The total area was estimated by him at about sixty acres, with five to twenty-two of the structures to the square foot. Those to which his attention was first drawn, occupied a small tract of woods that had recently been burned over. Subsequent visits extended the area far beyond this tract, and included ten acres of open land which had been wooded in 1877. Other localities of the chambers, varying in their extent, were also found by him at Nyack, Upper Nyack, South Nyack, Grandview, Piermont, and on the top of the Palisades near Alpine. Several of these areas had been burned over. Mr. Lawton, superintendent of schools at Nyack, found the chambers in small numbers on a slight terrace in his yard, and although hundreds of the insects came up in other portions of the yard, no chambers were built. Quite a number were found at West Point; at New Windsor, Miss Morton observed them in the grass and in the rows between the garden plants. A few, which were about two inches long and nearly horizontal, were reported from Johnsville. They were also seen at Marlboro in the woods, and probably further search would have revealed others. In the sandy soil of the woods along the river at Poughkeepsie, the ground was thickly covered with them. At Bangall they were found under the leaves in the woods among three times as many uncapped holes: several acres were dotted with four to ten holes to the square foot. At Athens, in one locality, the soil was not much over two feet in depth where the chambers occurred, while in another locality covered with bushes, no rock could be found at a reasonable depth. Mr. Brooks of Athens had noticed the chambers in his apple orchard in great numbers when cultivating it. The clay was then

dry and would come up in quite large pieces holding the chambers, but they did not appear much above the surface. Mr. H. Van Slyke found on May 15th, the chambers very abundant at New Baltimore, distributed over a fifty-acre lot from which the brush and small growth had been burned about three weeks before. Over much of the ground, there were about eight to ten to the square foot, while in places, nearly three times as many could be counted in the same space. Frequently they crowded one another, and from three to five had been fastened together in their building. Very few of any height were built erect: most of them curved slightly just above the ground, and in many instances the cavity toward its end was nearly horizontal. They varied in height from 1½ to 3½ inches; in breadth from 1 to 1¼ inches; general height 2 inches; diameter inside ⅝ inch, rarely ½ inch. (Pls. X to XIII.)*

About 80 examples of these interesting structures, representing their peculiar forms and varied material, are in the State Collection, from the following localities:

North Fakins, Knox Co., Missouri; Rahway, N. J.; the following New York localities: Rural Cemetery near Albany, Bath-on-Hudson, New Baltimore, New Scotland, Athens, Poughkeepsie and Nyack.

In New Jersey they were reported to Dr. Smith from several localities. At Port Elizabeth a recently burned tract of 100 acres was covered with the buildings. They were also found on the Orange Mountains back of Montclair, on the Palisades above Fort Lee, at Closter, Demarest, Cresskill, Englewood and New Durham. The occurrence of the above-ground chambers was not reported in Connecticut.

Construction of the Chambers.

The chambers are constructed by the pupæ with soft pellets of clay or mud brought up from below and pressed firmly into place. On examination it will be seen that they are well rounded and firmly and rather smoothly compacted within, although the marks of the claws of the pupæ are plainly to be seen. Leaves and sticks are often incorporated in the outer portions of the walls. Mr. Lander, of Nyack, has recorded that in one corner of his garden, open towers only of about one inch in height were built with no attempt at roofing them over. It would be interesting in this case to know whether or not the process was suddenly interrupted by some nocturnal prowler devouring the little builders. In this connection may be noted the

* These plates are views taken for me at this locality through the kindness of Mr. W. W. Byrington, of Albany

interesting observations of Mr. Lawton on the repairing of injured chambers. He found that in every case, except one, the pupæ repaired them soon after the injury by bringing up pellets of mud and roofing over the broken portion about half an inch from the top. The repairs were begun on one side and gradually extended over the opening horizontally, there being no attempt to form a dome-shaped roof. Some of the chambers which had been broken off at 12:15 P. M., were found with a few pellets in position at 12:45, and three hours later the opening was entirely closed over. At one time a pupa was caught with a pellet of mud in its claws.

When the time for the final transformation has come, the pupa makes its way out of the chamber through a rounded hole made by it near the top, of a size barely sufficient to admit its passage.

The Purpose of the Chambers.

Most of the habits of animals are of direct advantage to them, or else they may be explained as the persistence of some formerly useful, but which under changed conditions are no longer of value. The Cicada buildings were first found on low wet soil after heavy rains, and the natural inference was that they were constructed for the purpose of escaping excessive moisture or flooding. In 1894, they were first noticed on tracts recently burned over, or in places where the soil was comparatively shallow. The early spring had been unusually warm, and the theory was advanced that these structures were reared to protect the insects from the heat — the elevation and slope of the land in many cases rendering the earlier theory untenable. Unfortunately for this explanation, the pupæ persisted in building their above-ground chambers where the soil was far from shallow — under the leaves in woods not recently burned over, and in other places where the ground would not become unnaturally heated. It should also be remembered that the pupæ had only to descend to a moderate depth if uncomfortably warm, and that in open fields, at least, the above-ground chambers would be much warmer on a sunny day than a subterranean burrow. Moreover, their occurrence, sometimes almost covering large tracts, and again alternating with open burrows or disappearing altogether, renders a broad generalization concerning their purpose extremely unsafe.

It may be, as suggested by Mr. Lander, that the above-ground chambers are the work of those coming to the surface earlier than the proper time for their final change, as they were probably built in April or early in May, while the imago did not appear as a rule until the latter part of

May or early June. If the insect spends a week or more in the vicinity of the surface, it is manifest that a burrow capped with one of the chambers would be more secure than an open one. There are a number of causes that might hasten this upward movement; *e. g.*, the amount of water in the soil, a greater supply of food nearer the surface, a restlessness of the insect as the time for its emergence approaches — often observed in other insects, etc. The building of chambers at the surface may not be so exceptional as at first appears. There are several records of their being found in limited numbers under fallen leaves in forests, and slightly above the surface in cultivated fields — in the latter place hardly noticed until disturbed by the cultivator. It is probable that they would have been found in many other localities than those recorded, had search been made. Their being so often reported in 1894 on tracts recently burned over may be entirely owing to their ready exposure to the eye in such localities.

First Notice of the Chambers.

The earliest notice that we have of these Cicada chambers is that of observations made by Mr. S. S. Rathvon, of Lancaster, Pa., which were communicated to Prof. Riley and published by him in his *First Report on the Insects of Missouri*, accompanied by figures of a chamber received from Mr. Rathvon. Prof. Riley mentions his having previously found them in a field being plowed near St. Louis, Mo. The only other published notice of the chambers prior to the widespread interest excited by their occurrence in many places in the State of New York in 1894, appears to be one by Prof. J. S. Newberry, who in 1877 had his attention called to their discovery in a cellar in New Jersey, and nine years later published an account of them in the *School of Mines Quarterly*, vol. VII, 1886, pp. 152–154. As the communication is an interesting one and not easily accessible, it is given herewith:

Uneducated Reason in the Cicada.

In 1877, a colony of the seventeen-year locusts (*Cicada septendecim*) appeared at Rahway, N. J. During the interval between the appearance of that and the preceding generation, the town had been extended, and some houses had been erected where forests or fields existed before.

One of these houses — that belonging to Mr. Alonzo Jaques — was constructed on the site of an old orchard, and had a shallow cellar. This cellar was kept closed till about the time of the advent of the Cicadas; the door was then opened, and the bottom of the cellar was found to be thickly set with mud-cones or tubes, from six to eight inches high, an inch to an inch and a half in diameter, each of which had been

formed by the pupa of a Cicada that had emerged from the earth beneath the cellar. Finding a dark chamber, and apparently desiring to work up to daylight, the Cicadas had taken the moist clay and of this formed pellets with which the tubes were built up, apparently with the purpose of bridging over the vacancy and thus reaching the surface.

These facts appeared to me so interesting that I procured a large number of the tubes, and I had the first report verified by the written testimony of the owner of the house and several other well-known citizens of Rahway.

The document sent me with the tubes has remained in my possession to the present time. It is dated June, 1877, and reads as follows:

"These cones were erected by the pupas of the Cicada in the cellar of a house belonging to Alonzo Jaques, Rahway, during parts of May and June, 1877. They were built in an unfloored cellar of a house constructed about eight years ago in an old orchard. The cellar was dug to about the depth of a foot in red clay, and the bottom covered by a slight layer of debris, sand, sticks, etc. The cellar was perfectly dark during the construction of the cones, the only opening being shut. The locality is a dry one, the house being situated on a rise of ground, and about a quarter of a mile from the nearest water — a ditch dry in summer. These cones were not seen in the course of erection, but when the cellar was opened, about the time the locusts made their first appearance, the whole cellar bottom was covered by them. The tops of all were closed, but on breaking some of them the pupas were seen both in the hole in the ground and in the cone.

"After the cellar had been opened and left so, they appear to have stopped building and to have made holes in the tops of the cones for their exit. These cones were a great curiosity to the people of Rahway, and many came to see them, declaring them something entirely new in their experience."

(Signed) A. E. CROW,
ALONZO JAQUES,
W. B. DEVRIE,
M. L. CROW.

In the facts cited above we have evidence of the exercise of intelligence in the Cicada, and a judicious adaptation of means to an end in circumstances that it would seem must have been without precedent in the experience of that or any preceding generation; and, therefore, for which no education of ancestors could have given a preparation. It is possible that the pupa of the Cicada is sometimes embarrassed in its ascent to the surface, by water, by too wet or too dry sand or mud, but it is hardly possible to imagine circumstances where the construction of a tunnel would be necessary.

In the earth, caves of any considerable size rarely or never occur, since surface water is constantly flowing through all superficial materials, and filling cavities with transported matter. Caves often occur in rocks, but the Cicada has no power to penetrate rock, and lives in earth near the surface.

Perhaps some of those who have made the habits of the Cicada a study, can suggest a school in which they could have received the training that fitted them for the engineering work they attempted in the case

under consideration; yet, though I have studied the habits of various colonies of the Cicada with some attention, I am quite at a loss for any explanation of the phenomena that will bring them in the scope of the theory according to which all our organs and faculties are the result of formative influences progressively developed through a long line of ancestry.

In whatever way the problem shall be solved, it has seemed to me of sufficient interest to warrant placing the facts on record.

Are the Successive Broods Dwindling in Number?

The long term of years elapsing between the appearance of a brood renders it difficult to obtain satisfactory answers to this question from more than a few localities. The following are confined to localities within the State of New York:

At New Windsor they were reported fully as abundant in 1894 as at the two preceding visitations in 1860 and 1877. They were much more abundant at Hillsdale and in greater numbers at Johnsville than at the former appearance. Mr. Frederick Clarkson reports them less abundant in Westchester county, while at New Brighton and Livingston they were much more numerous than he had ever seen them, the ground being a network of holes in many places. At Nyack they were perhaps not as plentiful as in 1877, although 80 holes to the square foot could be counted in places, and at Rock City they were equally abundant. There were about the same number in 1894 as in 1877 at Clermont, Claverack, and Marlboro, and not so many at Barrytown. They were evidently losing ground at Heath, for they were fewer in 1894 than in 1877, and then not so numerous as in 1860. One report gives not so many at Clarksville in 1894, while another states that they covered more space but were not so plentiful where they appeared as in 1877. None were reported from Tarrytown although they were said to have appeared there in 1877. Mr. Nathan Banks looked for them several times, without detecting any indication of their presence, in a piece of woods near Westbury, Long Island, where they were seen in 1877. The observations of James Angus communicated to me by letter, on their occurrence in Woodlawn Cemetery, New York, are of interest as indicating in a marked manner the effect of cultivation on this insect. No Cicadas were found by him in the improved parts of the cemetery, except under one large white oak tree, although they occurred in the unimproved portions. In preparing the land for interments it was trenched to a depth of at least six feet, except, presumably, in the vicinity of this tree, and here the insects thrived, as was evidenced by the thousands of pupal shells which could have been raked together beneath its spreading branches.

This Cicada appears, as a rule, to be found in the greatest abundance on wooded heights, as the Palisades on the Hudson and similar localities, —its numbers decreasing on the lower grounds and back from the river. At New Haven, Conn., none were seen on a damp spot of about an acre in extent in the midst of a numerous colony. At Poughkeepsie, N. Y., they were most abundant in low swampy places, and very abundant directly on the shores of the river. The insect probably can not live in soil constantly saturated with water, although it may thrive in wet soils, and this difference may possibly exist between the wet locality at New Haven and the swampy places in the vicinity of Poughkeepsie. An idea of the abundance in which it appeared in certain localities may be gained from the following notes. At Nyack they occurred "in millions; the ground in many places was honeycombed with holes, and the cast pupal cases could be gathered by the peck." They completely covered the ground in some places at Rock City, and often the holes from which the pupæ came were but half an inch apart. At Annandale six of the cases might frequently be counted on a single leaf. At New Windsor, according to Miss Morton, when the insect was most abundant its noise was bewildering, and continued day and night, only intermitting for an hour or two after sunset, and commencing again with the rising of the moon (*in litt.*). At Clermont, Columbia county, the noise was almost deafening when at its height, according to Mr. Clermont Livingston, and it was heard at night after the moon rose. The Cicada was also heard in other localities on moonlight nights.

It is natural that the number of Cicada should vary from generation to generation, as other species of the insect world are known to do, and that the territory occupied by them, in consideration of the clearing of forest lands and cultivation, should be subject to continual fluctuation. So although this brood was not found in 1894 at several places where it was seen in 1877 and occurred in diminished numbers in others, yet the positive evidence of their presence in much larger force at some, and in at least equal strength to their former advent in many other places, would seem to militate against the conclusion that this brood was dying out. That it was not recorded within forty miles of its extreme northern extension in 1843 given it by Dr. Fitch (Schuylerville), may be entirely owing to no special effort having been made for its detection along the upper Hudson.

Damages by Oviposition.

The main, if not the only serious damage inflicted by this insect is that caused by its deposit of eggs in the twigs of various trees, — the

amount of harm resulting from the puncturing of twigs for food is not known. The oviposition is largely in forest trees — in oaks, hickory and chestnut. Among cultivated trees the peach, apple and cherry suffer the greatest injury. The eggs may be found in almost all trees and shrubs, excepting those of the pine family; they are occasionally placed in cedar twigs. In 1894, the period of oviposition extended from about the first week in June to near the middle of July, but most of the eggs were probably deposited during the last ten days in June and early in July. The injury to the trees appeared to be mainly mechanical, resulting from the numerous slits in the twigs, forming almost continuous lines, pierced for the reception of the eggs. The damage to large trees, as a rule, was not serious, although some broken twigs and dead leaves gave them an unsightly appearance. Young trees were injured the most, and in some cases they were nearly ruined.

The reports received from various localities in 1894 concerning the injury wrought by this insect varied widely in character. In a number of places little or no damage was reported. At New Windsor, where it occurred in great abundance, Miss Morton reported that many limbs of small trees were killed, and in a few instances very little was left of the tree. Mr. H. D. Lewis is authority for the statement that at Annandale, thousands of thrifty young trees were virtually ruined by this insect. That this would naturally be the result of excessive oviposition, will appear from the following:

At Hillsdale, N. Y., in a twig nine inches long and one-fourth of an inch in diameter at its larger end, seventy slits were counted, — each slit containing about twenty-four eggs, or 1680 for the entire number. The Cicadas injured young hickories so greatly at Highland Falls as to render them unfit for hoop poles. In some localities the woods were said to appear as if fire had run through them. As a general rule, however, the damage by this insect was not great. Young trees undoubtedly suffered greatly in localities where the insect abounded, and the larger ones were severely pruned, but in most of the latter, the injury was more in appearance than in reality, — the pruning not proving very injurious, although at the time the dead leaves gave an impression of permanent harm.

Serious Results Reported From Cicada Stings.

Stories of the injurious and deadly character of the sting by this insect were widely circulated and firmly believed by many. A boy at West Point, George Pavek, was reported to have been bitten June 19th on the hands and face and to have died in a few hours, — medical aid proving

of no avail. Subsequent investigation and a letter from the father of the lad, proved the story to be utterly false.

A school-girl, whose name was given, was reported to have been stung in the back of the neck by a Cicada that flew into the school-room: she was taken home in a carriage and died in great agony the following morning. This story had even less foundation than the preceding, as it could not be traced to any reliable source, and the name of the person was not known in the locality where it was said to have occurred.

Mr. H. D. Lewis, of Annandale, N. Y., was reported to have been stung so severely as to necessitate the amputation of a finger. His reply to the inquiry made of the truthfulness of the report, was as follows: "Allow me to say that the report of my being stung and the amputation necessary was pure invention, as I still retain the allotted number of bodily members unimpaired."

The story of a swarm of locusts attacking and killing a horse near Jacksonville, Pa., at the foot of South Mountain, is also another newspaper report deserving of no credence.

During the last advent of the Cicada in the Hudson river valley, hundreds and possibly thousands of persons handled the insects. Many school children amused themselves by playing with them. After investigating the newspaper and other reports of fatalities and injuries inflicted by their sting, and mailing nearly one thousand circulars throughout the region visited by the Cicada, in which special inquiry was made in relation to persons stung by it, only one instance of the kind was reported, and even in this there was reason for doubting that the slight wound had been inflicted by a Cicada. From the above, in connection with other investigations, there is good reason to believe that the insect is incapable of inflicting a dangerous or severe sting, and that the fatalities ascribed to it in the past are pure and simple inventions.

Natural Enemies.

A Cicada year is a time of unusual feasting for many vertebrates in the locality where it occurs. Cats and dogs eat the pupæ as they emerge from the ground. Skunks, ground-hogs and grey squirrels have been observed feeding on them, and it is probable that several other quadrupeds avail themselves of this abundant food-supply so easily obtained. Domestic fowls of all kinds eat them greedily,— in some places they were known to remain in the woods the entire day feeding on them. They are eaten by most of the insectivorous birds. Robins are said to prefer them to strawberries, and the crow devours them in preference to corn.

The English sparrow was observed to feed on them continuously in some places, while in others the occurrence was rather rare. Dr. J. B. Smith has recently stated: "This bird seems to have an intense hatred for the insects, attacking and pulling them to pieces in the most wanton manner. Near the large cities where the sparrows are numerous, entire broods have already been destroyed." Other birds that may be named as feeding on the Cicada are: the cuckoo, king-bird, oriole, sparrows, cat-birds, thrushes and ground-bird. Even the common land turtle was tempted to include the pupæ in its brief bill-of-fare.

The only insect enemies that were seen to attack the Cicadas were species of ants. They probably did not often molest the living, but contented themselves with preying on the dead or dying.

The fungus, *Massospora cicadina*, was found destroying the insect in widely different localities. At New Windsor, N. Y., many old males were found infested. The same conditon was reported at Nyack and at Clermont; at the latter, it was thought that possibly a few females were similarly affected. The infestation was also observed at Bay Chester and Clarksville, N. Y.; it was reported from New Jersey, in many instances at Morristown, and in a few at New Brunswick. The fungus was not found at New Haven, Conn. Failure to learn of it in other localities, by no means implies its absence, but merely that it was not seen.

Preventives of Injury.

It is practically impossible to prevent the Cicada from ovipositing in the twigs of trees, unless they are small and their value would warrant the expense of enclosing them with fine netting or light cloth so as to exclude the insect during the egg-laying period.

Since the greatest injury is done to young trees, much loss could be avoided by refraining from setting out new stock for the two or three years preceding the time for the appearance of a brood. This would be of special importance in the vicinity of forests, or on land which had borne a growth of trees at the previous advent of the insect that had suffered from its attack. In such localities it would be well not to prune older trees the spring before the appearance of the Cicada, unless the pruning be made so severe, as to leave no slender tips to serve as an invitation for the insect's oviposition.

Pemphigus rhois (Fitch).

The Sumac-Gall Aphis.

(Ord. HEMIPTERA: Subord. HOMOPTERA: Fam. APHIDIDÆ.)

FITCH: in Month. Journ. N. Y. St. Agricul. Soc. for Aug., 1866, p. 73 (described, as *Byrsocrypta rhois* with remarks).
WALSH: in Proc. Entomolog. Soc. Phil., vi, 1866, p. 281 (referred to *Melaphis*).
PACKARD: Guide Study Ins., 1869, p. 524, fig. 523 (brief mention).
WALSH-RILEY: in Amer. Entomol., i, 1869, p. 108, fig. 89 (brief mention, in Illinois and New York).
THOMAS: 8th Rept. Ins. Ill., 1879, pp. 152-153, fig. 28 (brief mention).
LINTNER: 3rd Rept. Ins. N. Y., 1887, p. 142 (from Schenectady); in Country Gent., lix, 1894, p. 686 (brief account); 10th Rept. Ins. N. Y., 1895, p. 503 (abstract of preceding, all as *Melaphis*).
OESTLUND: Bull. 4 Geolog. and Nat. Hist. Surv. Minn., 1887, p. 23 (bibliography, description, remarks).
SMITH: Cat. Ins. N. J., 1890, p. 451 (listed).
RILEY-HOWARD: in Insect Life, v, 1892, p. 145 (tannin in gall).

This insect is rarely seen, except by those curious enough to cut open one of the galls that it forms on the leaves of sumac. If the examination be made in September, it will be found tightly packed with particles of white flocculent matter which are the cast skins (exuviæ) of the lice at their successive moltings, hundreds of yellow-green wingless aphides, with wing-pads upon their sides (the pupal stage of the insect), and a smaller number of matured winged forms. A little later all will have become winged.

This insect was referred to the genus *Byrsocrypta* by its describer, Dr. Fitch, in 1866. Shortly thereafter Mr. Walsh made it the type for the new genus *Melaphis*, but upon insufficient grounds, according to Mr. Oestlund, who has recently placed it in the genus *Pemphigus*.

Description of the Gall and Immature Aphides

The galls have been described by Dr. Fitch as follows:

Resembling little round balls of different sizes, the largest measuring an inch in diameter, their surface uneven and slightly knobby in places, and covered with fine erect white hairs; their color pale buff-yellow or greenish-yellow, and on the side exposed to the sun bright crimson-red. Attached to the leaf by a narrow neck, opposite which, on the upper side of the leaf, is a thickened wart-like elevation, or sometimes higher conical protuberance, which is also covered with erect white hairs; and the leaf itself is partly withered, and turned red or yellow. Cavity inside large; in the smaller galls filled with small, oval, pale dull yellow lice of different sizes, their eyes black, their feet and antennæ white, the larger ones measuring 0.03 in length, and some of these larger ones thinly

covered with a very fine pruinose powder, resembling mold; some having small scales or rudimentary wings, showing them to be pupæ; their cast skins thickly interspersed among them, resembling white meal; the larger galls with only the walls of the cavity covered, and crowded with similar lice.

Exception should be taken to Dr. Fitch's comparison of the galls to "little round balls of different sizes." All that have come under my observation are elongated, and decidedly pyriform in shape, as may be seen in figure 1 of Plate XIV, which fairly represents quite a number of others in the state collection. It is probable, however, that examples of rounded forms may at times occur, if we may judge from the peculiarly shaped one (almost semi-globular) represented by Walsh-Riley in the figure given by them, and reproduced by Dr. Thomas in the 8th Missouri Report, and also by Dr. Packard in his "Guide to the Study of Insects."

Description of the Imago.

Winged female, 0.06 in length, and to the end of wings 0.10; pale dull green or yellowish-green; head and antennæ black; base of thorax blackish, and its anterior part light yellow; legs pale; wings hyaline, but not clear and glass-like, their veins black, the third one abortive nearly half its length, the stigma salt-white; abdomen commonly thinly covered on the back with fine pruinose matter, its middle rather deeper green; antennæ shorter than the thorax, thread-like, four-jointed, the first joint slightly the shortest, and the second joint rather the longest. (Fitch.)

Mr. Walsh has taken exception to the above description, in the following criticism:

Dr. Fitch's description of the winged female of this species applies only to immature specimens extracted from the gall. After they have been out some time, the legs and the whole body, except the collar which becomes very pale brown, turns to a decided black; and the stigma then is not "salt-white," but pale dusky with a whitish reflection.

Life-History and Food-Plants.

The life-history of the species, so far as known, may be briefly summarized as follows: The growth of the gall commences in the spring, when it may be found occupied by the wingless mother louse in company with her progeny in their larval stage. The occupants multiply rapidly, increasing largely in number until during September, when the gall matures and gives forth the colony, all becoming winged eventually.

The same gall occurs on the *Rhus glabra* and the *Rhus typhina*. In a note published in Insect Life (*loc. cit.*) it is stated that the galls of this insect on *Rhus glabra* contain nearly as much tannin as the ordinary

Cynipid gall from China and Japan, viz. from 60 to 70 per cent, or about three times as much as is found in the foliage. Thus it would appear that the irritation of the tissues by the insects causes a concentration of the tannin in the affected parts.

Distribution.

The galls of this insect are apparently not of common occurrence, or possibly it should be said, they are not frequently observed, since they are rarely if ever found on sumacs standing where they are exposed to the sun.

They have been recorded from New Jersey, and from several localities in New York, Illinois, and Minnesota. The species probably has a much wider, though local, distribution. According to Dr. Fitch, it was rare in New York, for in describing it in the year 1866 he states that he had not met with it during the nine preceding years, although he had diligently searched for fresh specimens, and was compelled to fall back on those gathered in 1857 for its description. Examples in the state collection from which the figure was taken were received on September 7, 1886, from Schenectady, N. Y., and others from Clinton, N. Y., were received in September 1894. They have not come under my observation in the field.

Gossyparia ulmi (Geoff.).

The Elm-Tree Bark-louse.

(Ord. HEMIPTERA: Subord. HOMOPTERA: Fam. COCCIDÆ.)

GEOFFREY: Histoire Abrégée des Insectes, i, 1762, pp. 512–513 (described, as *Coccus ulmi*).

HOWARD: in Insect Life, ii, 1889, pp. 34-41, figs. 1-5 (general account).

JACK, J. G.: in Garden and Forest, ii, 1889, p. 461, fig. 129 (at Boston, Mass., life-history, remedies); in id., iv, 1891, p. 184 (distribution, injuries, remedies).

LINTNER: 6th Rept. Ins. N. Y., 1890, p. 189 (at Marlboro and Albany, N. Y.); 10th do., 1895, p. 519 (abundant at Ghent, N. Y.); in Country Gent., lx, 1895, p. 425 (on willow at Loudonville), p. 585 (identified); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, pp. 60-61 (distribution in the state); 11th Rept. Ins. N. Y., 1896, p. 280 (abstract of C.-G. notice), p. 287 (from Loudonville, Albany, and Catskill, N. Y.).

PERKINS: Insects Inj. Amer. Elm, from 11th Rept. Vt. St. Bd. Agricul., 1890, pp. 81-87, figs. 61-64 (general account).

RILEY-HOWARD: in Insect Life, ii, 1890, p. 351 (?*Colastes* a parasite of); in id., v, 1892, p. 51 (occurring at Brighton, Mass.).
CRAW: in Bien. Rept. Cal. St. Bd. Horticul. for 1893-94, 1894, pp. 90-92, 2 figs. (in California, description and remedies).
COCKERELL: in Entomolog. News, vi, 1895, p. 325 (at Agricul. Coll., Mich.); in Canad. Entomol., xxvi, 1895, p. 31 (listed); in Bull. Ill. St. Lab. Nat. Hist., iv, Art. xi, 1896, p. 324 (listed, synonymy).
HILLMAN: Bull. 28 Nev. St. Univer. Agricul. Expt. Stat., 1895, pp. 3-8, figs. 1-3 (account of in Nevada).
LOUNSBURY: Bull. 28 Hatch. Expt. Stat. Mass. Agricul. Coll., 1895, pp. 23-26, figs. 13, 14 (brief account of in Mass.).
KIRKLAND: in Bull. 2, Ser. of 1897, Mass. Crop Rept. for June, 1897, pp. 35-37, fig. 5 (distribution in Mass., remedies).

The sad condition of the shade-trees in many of our larger cities, is exciting considerable attention and especially is this true where the elm-leaf beetle, *Galerucella luteola*, has become familiar through its defoliation of numerous elms, the recent destruction of many fine trees in the Hudson river valley, and the doomed condition of thousands of others. As if the long list of insect pests preying upon the foliage or burrowing within the bark and sap-wood of the elms was not sufficiently extended, another species has recently come over from abroad and is rapidly extending its range, and fast making itself a public nuisance from its blackening the foliage and branches and also the side walks beneath with its vile excreta.

Introduced from Abroad.

The elm-tree bark-louse, *Gossyparia ulmi* (Geoff.), like a large number of our most common and injurious insects, is an introduced species. The precise manner and time of introduction into this country are not known and probably will never be definitely ascertained. It was first brought to the notice of the U. S. Department of Agriculture in 1884 through Mr. Charles Fremd, of Rye, Westchester Co., N. Y., who at that time complained of the elms in his nursery being troubled with thousands of a red-looking mealy bug. The insect (represented in figure 2 of plate XIV) had probably been brought over on some nursery stock several years prior to its discovery at Rye. This importation is another illustration of the ease with which insects can be introduced from other countries on nursery stock.

History of the Insect.

This bark-louse was not determined at the time it was received by the U. S. Department of Agriculture from Mr. Fremd, nor in other send-

ings of the same by Mr. J. G. Jack, from Cambridge, in 1887 and 1888. In the autumn of 1888, it was discovered in several localities in the City of Washington. The following year a more complete series of its stages having been obtained from Mr. Jack, it was identified at the Department with the European *Gossyparia ulmi*. In July of the previous year (1888) it had been received by me from Marlboro and Albany, N. Y., and observed by Professor Perkins at Burlington, Vermont. It was also detected about this date in New York City by Mr. Henry Edwards, and in 1890 it was sent to Washington from Brighton, Mass. Some young trees at Palo Alto, California, were seriously affected by this insect in 1893. The next year it occured abundantly at Ghent, N. Y. In 1895, Prof. G. C. Davis found it numerous on the elms of the Michigan Agricultural College, and badly infested trees were reported by Prof. F. H. Hillman at Carson City, Nevada. About this time it made its appearance at Amherst and Brookline, Mass. The present year it was received by me from Catskill, and observation has shown it to be quite largely distributed in the vicinity of Albany and Troy in this state.

Its Distribution.

It will be seen from the above that this insect is now known to occur in six States in the Union besides the District of Columbia. In Massachusetts it appears to be extensively distributed over the state, as published in a recent notice of the insect by Mr. Kirkland. It is quite probable that it has already been introduced in the adjoining states of Rhode Island and Connecticut. From the occurrence of the pest at Burlington, Vt., there is little doubt but that it will soon invade New Hampshire and Maine, if it has not already done so. It is known to occur in several localities along the Hudson river valley from the City of New York to Troy. In the upper portion of this district, the insect has been found so abundant and generally distributed that the same condition will probably soon be reported for the lower Hudson.

The other recorded occurrences of this insect indicate a wide distribution for it in the future,—ranging from the Atlantic to the Pacific and, at least, from about the latitude of Washington, D. C., to near the Canadian border.

Injuries by this Pest.

It is impossible to estimate even approximately the damage caused by this insect in its eastern distribution, associated as it largely is with the destructive elm-leaf beetle.

Both at Boston, Mass., and at Carson City, Nev., its operations have been very injurious to the vitality of the infested elms. The trees in Albany and Troy have suffered severely from the combined attacks of the elm-leaf beetle and this scale insect. The many trees that have recently died, were probably killed mainly by the beetle, but many are now suffering severely from the work of *Gossyparia*. In the early part of June the secretion of honey-dew from the insects on a badly infested tree was so abundant as to keep the walk beneath constantly wet and in almost a slimy condition. One could stand under the trees and see and feel the continual shower of the tiny drops. The injurious nature of the work of the insect was more plainly evident in September, when its presence could be detected at a glance from some distance, by the blackened foliage and limbs of the infested trees—the copious secretion of the coccids on the leaf and branch having furnished the proper medium for the growth of the blackening fungus, *Coniothecium saccharinum* Peck. Thus the elm-leaf beetle and *Gossyparia* working on the same trees, transformed many from beautiful ornaments to hideous monuments of insect devastation. In this City and in Troy, *Gossyparia* seems to prefer the English and Scotch elms, although it occurs in limited numbers on the American elm. In both of these cities this pest is so generally distributed that it will largely aid the elm-leaf beetle in the destruction of our European elms, unless earnest effort be speedily made for the preservation of our favorite shade trees.

Description of the Insect.

It is only the adult females that, as a rule, attract the attention of the casual observer. They may be seen clustered along the under side of the smaller limbs and resembling, in a general way, a growth of lichens. The full-grown viviparous females just before giving birth to their young, are about 0.1 inch long, oval in outline, and with ends slightly pointed. They are surrounded with a mass of a white woolly secretion which also partially indicates the segmentation along their margin (Pl. XIV, figs. 2, 5). At this period the females are full of eggs which give a reddish stain when crushed.

The young are easily recognized on the infested limbs and leaves as dark-eyed yellow specks, being less than 0.5 mm. or $\frac{1}{50}$ of an inch in length. They are of an elongated oval form, rounded anteriorly and tapering posteriorly to a pair of pointed processes, each bearing a long and a short seta. Each segment of the body is indicated by a lateral spine; there is a row of six around the anterior border of the head, and a

double row down the middle of the back. The growing young become darker and finally assume a yellowish-red color. Each segment becomes covered with spiny processes secreting wax. The general form of the young larva is retained (Pl. XIV, fig. 4). The antenna of the female before impregnation, is composed, like that of the young, of six segments, the second and third being the longest and the fourth and fifth shortest. The antenna of the immature male has six nearly equal segments and a longer seventh.

The oval cottony-like cocoon of the male is represented in figure 3, of Plate XIV. The presence of the insect within may be known by its two long protruding anal filaments.

The male will rarely be seen by most observers. It is a delicate two-winged creature of a reddish color, with rather large antennæ for so small an insect. It moves slowly over the limbs with a clumsy air. It is not easily disturbed and rarely takes to flight. An interesting feature is the occurrence of two forms. The earlier to appear,—the pseudimago,—is characterized chiefly by wing-pads in the place of normally developed wings. A few days later the perfect males with fully expanded wings come forth. Although the pseudimago is incapable of flight, it can probably perpetuate its kind, as it has been observed in coition.

Life-History.

This insect is the most conspicuous in the months of April, May and June, as the females are then about full-grown and are preparing to give birth to their young. Their active yellow progeny make their appearance in the latitude of Albany early in July. They move rapidly over the bark for a time and then settle along the veins of the leaves, principally the midvein, and in large numbers on the greener tips of the twigs. A few may be found in the crevices among the old females. They remain in these positions until into September or later, when many desert the leaves and establish themselves on the bark of the twigs for the winter, although it appears that numbers do not take this precaution in time, but fall with the leaves and are scattered by the winds. Many of the latter must perish, although a few may live to establish colonies in new localities. The winter is past in the immature form, the insects being about two-thirds grown, and protected by a whitish excretion from the numerous processes covering the dorsal surface. At the first warm weather in the spring, the wintered individuals show signs of activity. Early in April the females molt for the last time and the males form their cocoons. At this time many travel some distance before selecting a suit-

able place on which to settle. This is especially true of the males, as their snow-white cocoons are more rarely found in the center of a mass of the females than at the ends of dry twigs and other places unsuitable for the opposite sex. An abundant secretion of honey-dew occurs from the time the insects resume their activity in the spring until near the time that the young appear. The males remain in the pupa state for a few days only. A few pseudimagos emerge first (about six days after pupation), which are followed a week later by the perfect males. These soon perish after pairing,—the young not appearing until over two months later as indicated above. Soon after pairing, there is a marked difference in the features of the female. Her form changes from elliptical to oval, the secretion of the wax is more copious and is mainly from the lateral spines instead of from both lateral and dorsal as during the early autumn.

Means of Distribution.

The comparatively recent introduction of this pest and the establishment of its colonies in distant states, show very clearly how great a factor the shipment of nursery stock may be in the distribution of injurious insects. The rapid spread of this insect in eastern cities where it has obtained a foothold is surprising, and must be largely attributed to other means. It was not discovered in Albany until 1889. In the short space of seven or eight years it has spread to a large number of trees in all parts of this city and of Troy, where it is so generally distributed that perhaps three-fourths or even a greater portion of the elms are infested to some extent by it. It is by no means easy to explain how this spread was effected unless through the agency of birds. That notorious public pest, the English sparrow, has undoubtedly been an important agent in its distribution. It is but the work of a moment for the active young to crawl upon the foot of a bird touching the limb, and leave it at any later time. Many infested trees are so isolated, that there must be some such means for the conveyance of the wingless forms from one tree to another. It is possible that some of the immature insects falling with the leaves in the autumn may survive the winter and found colonies in new localities to which the leaves are carried by the winds; but this means of distribution would at best be quite limited and uncertain, and by no means could account for the spread of the wingless female throughout so many states in less than a score of years.

Natural Enemies.

No natural enemies of this coccid have been observed preying upon it in this country, so far as known to me. Professor Perkins mentions the occurrence of a number of hibernating lady-birds, on infested trees, the most numerous species being *Adalia bipunctata*, and suggests that they might possibly feed upon it. The lady-birds were very common in Albany in the summer of 1897, and were noticed in large numbers on trees infested with various species of plant-lice, but none were observed actually attacking, or in the immediate vicinity of, the *Gossyparia*. Many flies and other insects were seen about infested trees, but they were evidently attracted by the honey-dew, and could not therefore reasonably be considered enemies of this insect.

Remedies.

Perhaps the best remedy for this pest is spraying with kerosene emulsion or a whale-oil soap solution. The insecticide should be applied either in the early spring just after the hibernated forms have molted or soon after the young make their appearance. Late in the autumn the insects are so well protected that a solution of four times the normal strength would be needed for killing them. It might be preferable to treat the trees at this time, as the insects may then be directly reached in the absence of leaves, although a stronger solution would be necessary than earlier in the year. Small trees have been effectually cleaned by going over them with a stiff brush. The brush would be made more effective by dipping it in either kerosene emulsion or a whale-oil soap solution from time to time. It may possibly be found that a heavy stream of cold water thrown directly on the insects would reduce them to harmless numbers, if repeated several times during the season. Where convenient, this, from its simplicity, might be preferable to other methods.

Neuronia pardalis Walker.

(Ord. NEUROPTERA : FAM. PHRYGANIDÆ.)

WALKER: Cat. Sp. Neurop. Ins. Br. Mus., Pt. 1, 1852, p. 7 (description).
HAGEN: Neurop. N. Amer., 1861, p. 250 (description from Walker); in Proc. Bost. Soc. N. H., xv, 1873, p. 293 (from N. H.); in Beitr. kennt. Phrygan., 1873, p. 394 (description and remarks); in Psyche, i, 1875, p. 96 (rarity).
HARRIS: Entomolog. Corr., 1869, p. 333 (description).
BANKS: in Trans. Amer. Entomolog. Soc., xix, 1892, p. 362 (listed).

An example of this insect, was taken in Keene Valley, N. Y., in June, 1896, which, so far as known, is its first capture in the State of New York. Mr. Howard Notman, its fortunate collector, has kindly sent a colored figure of the insect, from which the accompanying illustration has been taken. It is apparently a rare species. Dr. Harris has recorded two examples of it captured near the Great Monadnock mountain in New Hampshire. Dr. Hagen has given "Nova Scotia (Redman)" as its habitat in his enumeration and description of the eight North American recorded species. Mr. Banks has added Canada and Labrador to its localities.

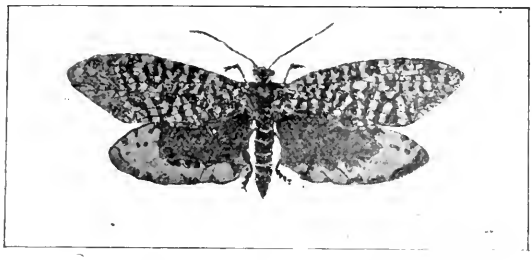

Fig. 7. — NEURONIA PARDALIS. (After Notman.)

At a meeting of the Cambridge Entomological Club in October, 1874, Dr. Hagen mentioned among the rare captures for the year, an example of this species, of which he remarked: "The only nearly related species live in Japan, the northern part of Europe, and in Liberia. They have the peculiarity to fly very high; this specimen was taken on top of a stage coach."

The following is Dr. Harris' description of the insect:

Body dark brown, antennæ, with the upper part of the head and thorax, black, the latter having two abbreviated fulvous lines; upper wings brown, with numerous large, rounded, tawny spots in rows between the nervures; hind wings brown, with a broad, tawny, tranverse band near the tip, and attaining the margin at the anal angle; base spotted with tawny yellow upon and behind the anterior edge; head beneath, with the palpi, coxæ, anterior thighs and tibiæ and bases of the intermediate and posterior thighs, fulvous.

Leptodesmus sp. ?

Thousand-legged Worm Infesting Green-houses.

(Class MYRIAPODA: Ord. CHILOGNATHA: Fam. POLYDESMIDÆ.)

A gentleman in charge of some private greenhouses in Kansas City made complaint of "a pestiferous, repulsive pest" which is proving very injurious, and which it has not been possible to control. Accompanying the specimens sent he has written:

We have used ammonia — one tablespoonful to four quarts of water, soapsuds, and slacked lime. We have taken off the pots from the benches in this particular house and covered them with powdered lime — then put on two inches of cinders and replaced the pots, and still the worms come, lying under each pot on top of the cinders. The benches were also cleaned and flooded with boiling water, and even steamed with a hose attachment. Can you tell me what the species is and how to eradicate it? One of the greenhouses contains three beds of earth that was mixed with sheep manure from stock yards here, by a florist employed. They are everywhere in this house, and nearly everything planted in beds is dead or dying; but begonias, geraniums, colias, heliotrope, etc., in pots, are doing well in spite of the pests sticking to the bottom of the pots."

The greenhouse pest of the above communication proves to be, upon examination of the specimens sent, one of the numerous species of "thousand-legged worms" that occur in the United States. Those that usually come under observation have rounded, cylindrical bodies, as seen in the family Julidæ. Those received, are flattened and spreading out at the sides, where the numerous short legs with which they are furnished have somewhat the appearance of a fringe (Pl. XV, fig. 1).

Description of the Millepeds.

Most of them are about three-quarters of an inch long, of a reddish-brown color, and are apparently full-grown, while others are about one-half inch in length and whitish. The head bears six-jointed attennæ sparsely clothed with coarse setæ (Pl. XV, fig. 3), and the body of the male 30 pairs of legs,—a pair on the first, second, fourth, and seventh, and two pairs on the fifth, sixth, and eighth to the eighteenth segments inclusive; the last two segments legless (apodal); the female has 31 pairs of legs, there being two pairs on the seventh segment; the hinder angles of the segments are acute. Repugnatorial pores surrounded by slight swellings occur on segments 5, 7, 9, 10, 12, 13, 15–19 inclusive. The smooth convex dorsal plates with only a slight transverse sulcus are characters of the genus *Leptodesmus*, to which this form is referred. At the bottom of the transverse sulcus there is a minute tuberculate ridge.

The lateral carinæ are yellowish, feebly sulcate with two minute serrations, the anterior one bearing a small seta (Pl. XV, fig. 4). The rhomboidal gnathochilarium is represented in fig. 7 of plate XV. The copulatory legs of the male are abruptly flexed and terminate in four slender, curved processes (Pl. XV, fig. 6), which are nearly colorless, and vary slightly in form in different individuals.

In the event of this being a form new to science, it may be known as *Leptodesmus falcatus*, in allusion to the hook-like shape of the first process of the copulatory legs. This species was also found swarming in soil containing house plants in Albany, N. Y., the following season.

The Allied Genus Polydesmus.

It is evidently closely allied to the genus *Polydesmus*, of which a common form in Europe is *Polydesmus complanatus*, or "the flattened millipede" (fig. 8) — represented by Curtis and other writers as being one of the most destructive of its kind, feeding upon the roots of wheat, onions, pansies, and several garden products. Dr. Fitch, in his 10th Report on the Insects of New York, has given a detailed account of the habits of one of the "flattened centipedes" which he regarded as identical with the European *complanatus*. It seems, however, to be different, for that species has not been recognized as yet in our country. It is thought that the form that Dr. Fitch wrote of (without any accompanying description) may have been the *Polydesmus Canadensis* Newport,— figured and briefly described by Dr. Packard in his *Guide to the Study of Insects*, page 677, and referred by Bollman to *Polydesmus serratus* Say. He represents it as "crawling everywhere over the damp surface of the ground by night, in search of the nicest, daintiest food it could discover and withdrawing into the crevices under chips, stones, and similar situations during the daytime." The underside of cucumbers lying on the damp ground were often almost covered with them and the skin much eaten. The roots of onions when lifted were found eaten entirely off by them—completely arresting the growth of the bulb. From finding many of the worms in the stalks of cabbage distorted with warty swellings and cracks, Dr. Fitch was led to believe that they were the cause of the disease known as "anbury" or "club-foot" in cabbage.

FIG. 8.— POLYDESMUS COMPLANATUS, slightly enlarged. (From Brehms Tierleben.)

Study of American Myriapoda Desired.

The Myriapoda, a class embracing the centipedes and millipedes, have not been given much study in this country, and therefore comparatively little is known of them, either scientifically or in their economic relations. Many of the millipedes feed only on decaying vegetable matter and are, therefore, of minor economic importance. Of those recognized as injurious to vegetation from attacking living plants, we are still without knowledge of such approved methods of dealing with them as will ensure protection from their varied forms of attack — especially when so severe and general as above reported in the Kansas City greenhouses. To meet such an emergency, we can only give a few remedies that have been recommended, and suggest some methods which give promise of being aidful if not entirely efficient.

Remedies.

Lime has been represented as a remedy by several writers, yet it has not apparently been of particular service in the present infestation. John Curtis, the eminent author of "Farm Insects," states that soot spread over the surface of the ground will drive the plant-feeding millipeds away, and also recommends spreading old cabbage leaves as a bait for attracting them, when they may be killed with hot water.

As they are mainly nocturnal feeders, many can be killed by lifting the pots and sprinkling diluted or pure kerosene on the worms gathered beneath, or wherever they may be seen on the benches or elsewhere. The kerosene may be diluted by shaking it briskly in a pot, or better still by making it into a strong emulsion. Pyrethrum and powdered hellebore might each be experimented with as a contact insecticide, either in its powdered state or mixed with water.

Probably the best results would be obtained by the use of traps or baits. Small pieces of board laid on a damp surface would be attractive as hiding places. Dr. Fitch states: "On raising up a chip or fragment of board that happens to be lying anywhere in the garden, you will probably find lurking under it a dozen or it may be fifty of these worms."

The traps would be much more efficient if made more attractive by placing beneath them slices of potatoes, turnips, or carrots. In England, slices of mangolds have proved to be one of the best baits that could be employed. If the baits were poisoned by dipping them into a Paris green mixture, it would not be necessary to visit them so often for the collection of the worms.

I think it probable that the infestation of the greenhouses has come from the piles of manure brought into them, as millipeds are known frequently to abound in manure, and are believed to breed in it. If on examination they prove to be present in large numbers in the manure, some efficient measure that may suggest itself should be taken for destroying them in it, and the manure should be removed to some distance from the houses.

The following thorough measures proved, as might be expected, an effectual means of ridding the greenhouses of the pests. (See *Garden and Forest*, v, 1897, p. 348):

In the spring we removed all plants from the greenhouses, also all wooden benches, and everything but the bare brick walls and the glass roofs. The floors had been concreted. We burned sulphur in liberal quantities three times a week for several weeks. Then we dusted all interiors thoroughly with hellebore, and in the fall, just before replacing plants in the houses, we coated all interiors with whitewash. Since then we have not found a single one of these unpleasant pests.

Kansas City. J. G. C.

The above-mentioned treatment should exterminate almost any pest to be found in a greenhouse. Such a fumigation might well be given greenhouses that are empty or nearly so during the summer as a preventive to the undue abundance of any injurious animal or plant form the coming season. Then if a little care be exercised when the house is filled in the autumn, not to introduce any pests, very little trouble should be experienced in keeping the plants in a healthy growing condition.

APPENDIX

(A)

NOTES ON SOME OF THE INSECTS OF THE YEAR IN THE STATE OF NEW YORK.*

The year has been characterized by the absence of attacks of the usual severity of a considerable number of our common insect pests—particularly those that infest our fruit trees. I do not recall a year before the present one in which reports have not been received by me of abundance of the apple-tree aphis, *Aphis mali* Linn., and of injuries feared from it. The eye-spotted bud-moth, *Tmetocera ocellana* (Schiff.), which has become so destructive to orchards in the western counties of the State, has hardly been heard from. No abundant presence of the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, has been reported to me, nor of the apple case-bearer, *Coleophora Fletcherella* Fern. The apple-tree tent-caterpillar, *Clisiocampa Americana* Harris, has been less injurious than in preceding years. The hop-vine aphis, *Phorodon humuli* (Schrank), made its appearance late in the season—in August, in portions of Madison and Oneida counties, and the blackening of the leaves from deposit of honey-dew excited some alarm, but it is not believed that serious harm has been done.

So far as my observation has extended—confirmed also by the observation of several collectors and others,—with a few notable exceptions, the year has also been remarkable for a scarcity of insect life. Some short excursions made in the vicinity of Albany specially for collecting, were without any satisfactory results. My Adirondack collections were unusually limited. Apparently not one-fourth of the usual number of insects were abroad (exceptions to this were the common house-fly and grasshoppers). Mosquitoes, the gray-gnat (*Ceratopogon*) and the black-flies (*Simulium*), were among the rarities, even in the month of July. The scarcity of butterflies was particularly noticeable, and was remarked upon by others than entomologists. Not a single *Papilio Turnus* was seen nor any of the other Papilios, except one *Asterias*. No Graptas were taken,

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when in former years hundreds could have been captured. The Argynnids were very few and mainly *Atlantis*. *Feniseca Tarquinius*, for which Keene valley is a noted locality, was not seen. *Colias Philodice* was comparatively rare, while *Pieris rapæ* was abundant in the fields and about the blossoms of the burdock. The presence and capture of several examples of *Pieris oleracea* was welcomed as evidence that our once familiar native species had not been entirely driven away by the hosts of the foreign invader. In part compensation for the absence of so many of our diurnals, the beautiful "red admiral," *Pyrameis Atalanta*, was uncommonly abundant in the last week of July and in early August.

The night-flying species — the moths — were also very few, and it was only possible to secure a few of the attractive Plusias that abound at these high elevations; but among them were several examples of the resplendent *Plusia balluca* Geyer.

In each of the other orders was there an equally poor representation of the species commonly met with—quite noticeable in the families of the Cicindelids, Coccinellids, Cerambycids, in the *Bombylidæ* and *Syrphidæ*, in the dragon flies, and many others.

What particular climatic conditions had resulted in so marked a reduction in the usual abundance of insect life is beyond our knowledge. It would be interesting to know if any other class of the animal kingdom was similary affected, and if it also extended to the flora.

The following are brief notices of some of the insect attacks that have come under observation:

TENTHREDO RUFOPECTUS (Norton).

An example of this saw-fly was received May 25, from Mr. Thomas Tupper, of Corning, N. Y. It operates in the stems, after the manner of, and often in association with, the current-stem girdler, *Janus integer* (Norton). It had been common in his garden for many years past, but by cutting off and destroying each wilted tip last year as soon as seen, he had nearly checked its operations.

The insect appears to have an extended distribution. Norton gives it from New England, New York, Pennsylvania, and Illinois. Cresson, later, gives United States and Canada. It has been taken in a number of examples in Canada — at Ottawa and vicinity, between June 5th and July 1st. In my collections made at Schoharie, N. Y., it occurred as late as July 18th.

DATANA INTEGERRIMA Gr.-Rob.

The walnut trees in Bellport, L. I., have been almost entirely stripped of their leaves by the caterpillar of this species, according to reports received from Dr. H. G. Dyar, of New York city.

This is one of the most common of our Datanas, and its larvæ are often found assembled in large companies on the hickory. They also feed on walnut (*Juglans*), beech (*Fagus*), oak, and occasionally on willows and apple.

THE ARMY-WORM.

The notable entomological event of the year has been the occurrence and the ravages of the army-worm, *Leucania unipuncta*, over the greater part of the State — from its eastern to its western borders, and from its southern to nearly its northern boundary. It has been authentically reported from 55 of the 60 counties of the State. Its extension and the injuries committed by it are believed to be greater than had ever before been recorded in the State. When it appeared on Long Island and in Westchester county in 1880, although serious harm was done to the crops invaded, it was limited to the southeastern portion of the State, although spreading over some of the New England States, New Jersey and Pennsylvania.

Its habits have been similar to the many recorded occurrences elsewhere, unless that in many instances its operations were first observed in rye fields. From these it spread to oats, to timothy, and corn. Clover has been reported as eaten by it, and peas to a limited extent. Grass, of course, was consumed in its travels.

Of its abundance it may suffice to state: In many places they occurred in millions. Roadways crossed by them were "blackened" by their numbers. They "covered fences" and it has been said that they covered sides of buildings. The noise made by their feeding could be heard after nightfall. The clothing of a person standing for a short time in an infested field needed frequent brushing and picking over to remove them. The sight of their marching armies was said to be "nauseating."

Of the many preventives employed to prevent their ravages—as heretofore, plowing furrows with a perpendicular side toward the field to be protected from invasion, was the most effective and the one more generally resorted to. Attempts to save fields of barley, oats and timothy when once infested, were of little avail.

The earliest notice of the insect within our State, came to me on July 1st, when it were found on corn near Albany. This was followed on the 2d inst., by examples sent from Cambridge, Washington county; and for the week thereafter, reports followed closely and thickly of army-worm ravages in several of the eastern counties, and later, from southern and western parts of the State.

Larvæ received and collected by me were full-grown, and entered the ground for pupation as early as July 4th. Two changed to pupæ on the 9th on the surface of the ground in the box with the earth given them. On the 23d the moths commenced to emerge, and on the same date some of its parasites, *Winthemia 4-pustulata*, also made their appearance. Only a few parasites were disclosed. Their eggs had not been observed on any of the larvæ that I had examined, while in the western part of the State they have been reported as not at all uncommon.

THE WHEAT-HEAD ARMY-WORM.

The wheat-head army-worm, *Leucania albilinea*, has been reported from the town of Morley, in St. Lawrence county. I was informed under date of July 22d, that the caterpillar, identified from examples sent me, was doing much damage in barley fields. Its operations were shown, 1st, in the awns of the barley having to a great extent fallen, or more probably, been cut off: 2nd, a great number of the heads were cut off between the head and the next joint below. In one instance where the crop had been a most promising one, it was estimated by the owner, that two-thirds of it had been destroyed. The injury had not been sudden or rapid as in the work of *L. unipuncta*, but had been under observation for some considerable time. The barley-heads lying on the ground were subsequently eaten out, leaving only the husks or chaff remaining: this, it was thought, was done by the caterpillars.

A feature noticed in the work of this insect, was, that the leaves of the barley were not eaten—the first to be consumed by the army-worm, but that with the exception of the severed head, the plant was left in all its freshness and healthy appearance.

EUFITCHIA RIBEARIA (Fitch).

This insect, generally known as the "gooseberry span-worm," from the preference shown by the caterpillars for that plant, was reported in very great numbers, during the latter part of May in a garden in Pine

Plains, Dutchess county, N. Y., where it stripped the leaves of both gooseberries and currants and threatened the destruction of the bushes. It had been noticed for a few preceding years, and had been steadily increasing. This season it was beyond control either by hand-picking or jarring, and was proving a more serious pest than the currant-worm, as hellebore powder had little if any effect upon it.

Although this insect is represented as common by most of our writers, and according to Dr. Packard, "is everywhere abundant in the Northern States, flying in gardens and resting on the leaves of currant and other plants," it can not be numbered among the more destructive garden pests of the State of New York. The above is the first instance in which the attention of the State Entomologist has been called to the injuries of the caterpillar. Nor can it be common on our wild currants or gooseberries, for, to my surprise, in referring to the State Collection, the moth is represented in a single example taken in Keene Valley on July 21st, 1895.

Apparently the insect abounds in a locality for a few years and then diminishes or entirely disappears. It was more numerous, according to Dr. Fitch in 1847 when it was described and named by him than in any of the intervening years to 1857 when he again wrote of it. During this latter year, it proved very injurious to gooseberries and currants at Paris Hill, Oneida County, N. Y., during the third year of its presence.

THE CANKER WORM.

The spring canker worm, *Anisopteryx vernata* (Peck), which is quite local in the state and seldom very injurious, has this season been committing serious depredations in scattered localities. The present year, Mr. E. J. Preston has sent under date of May 21st, examples of the caterpillar of various sizes, with some of nearly full growth. He represents them as skeletonizing the foliage in several of the orchards in his immediate neighborhood. Efforts had been made to stay their ravages through Paris green spraying. When used in several orchards by a person employed who was familiar with spraying methods, a mixture of one pound of the green and four pounds of lime to 200 gallons of water, did not seem to kill a worm. The same in 150 gallons of water was also ineffectual. A third spraying with 100 gallons of water was next tried, the result of which had not been reported.

It would seem from the above, provided that the Paris green was of the standard purity, that the canker worm is almost as resistant to the effects of Paris green as is the larva of the gypsy moth.

Mr. Preston refers to the observed habit of the caterpillar, which has been frequently noticed elsewhere, of dropping from the leaves when they have been nearly all consumed, and hanging by a thread until carried by the wind to some neighboring tree, or else dropping to the ground.

To the orchardists of Amenia the canker worm is popularly known as the "fire worm," from the appearance of the leaves after all their green has been eaten away, as if they had been swept over by fire.

The canker worm has also been reported from Moreton Farm, Monroe county, and from orchards in Wayne county, as quite common, and from several localities in Western New York. The seasonal conditions have apparently been favorable for its multiplication.

CACŒCIA ROSACEANA (Harris).

Cacœcia rosaceana (Harris), known as "the oblique-banded leaf-roller," which feeds on an unusually large number of food-plants, has been quite abundant and destructive in apple orchards. It has been sent to me from several localities in Eastern and Central New York, as having been very injurious not only to the foliage and the blossoms but later in the season to the young fruit into which it ate rounded holes averaging one-third of an inch on the outside and larger within, and often extending to beyond their center. They attacked the fruit as soon as it had set, and continued until it had attained nearly an inch in diameter. The injury had been quite serious in the orchard of Mr. Morris Tompkins, of Germantown, Columbia county. The moths were known to him from having reared them from the caterpillars, and on June 13th, such numbers were drawn to light at night that apprehension was felt of the work of a second brood. Walsh and Riley have recorded as a habit of the caterpillar its gnawing off the rind of green apples, but I do not recall mention of its destroying the fruit by eating large holes into the interior.

Another caterpillar of larger size—of about an inch in length of a pale green color and marked with white lines and dots—is also chargeable with eating into the fruit, after the manner of the Cacœcia. I failed to rear the examples that were sent me, but it is not improbable that it may be *Nolophana malana* (Fitch). It appears that *C. rosaceana* may be in part, controlled by jarring. State Botanist Peck brought on the 18th of May, several of the larvæ which he had taken from his plum trees in jarring for the plum curculio. From one small tree, twenty larvæ fell upon the sheet underneath.

A CECIDOMYID IN CHOKE-CHERRIES.

The galls of a Cecidomyid larva on choke-cherry, *Prunus Virginianus*, were brought by State Botanist Peck, from Bethlehem, N. Y., on May 28th. The larvæ emerged and entered the ground, but none of the flies have made their appearance.

In Keene Valley, in former years, I have found this cherry very abundantly galled by apparently the same insect, in the month of July. Many larvæ were disclosed from them, but in the several attempts made to obtain the imago, all have met with failure.

The present year not a single galled cherry could be found in the localities in Keene Valley where in other years they had abounded.

These galls have been studied by Prof. Geo. F. Atkinson, of Cornell University, in connection with a fungus attack which he found to be usually associated with them—named and described by him as *Exoascus cecidomophilus* (see Bull. 73, C. U. Agricultural Experiment Station, September, 1894). It was not ascertained by him if the larvæ attack the fruit before or after the attack of the fungus. It was thought that the larvæ attack and deform fruits which are not affected by the fungus. In this he was probably correct, as I have no recollection of the fungus presence on the galls collected by me in Keene Valley.

This Cecidomyid has not as yet been described, although it has been observed by several entomologists.

EUPHORIA INDA (Linn.).

The larvæ of *Euphoria Inda* (Linn.), formerly known as the Indian Cetonian, were found in large numbers beneath chip manure at Menands, N. Y., in the latter part of June. From their general appearance and from their occurrence in manure, they were believed to be the "muck-worm," *Ligyrus relictus* (Say). Examples were brought to me within the manure inclosed in a box. Not long thereafter, they were found to have eaten all of the decayed portion, leaving only the bits and pieces of chips and a large quantity of rounded pellets of their excrementa. These, together with additional ones obtained, were transferred, on July 30th, to a larger box with an ample supply of food. The box was, opened from time to time, until the 8th of August, when two *Euphoria Inda* were resting on the surface. Examination of the contents, gave the following: Two perfect beetles within their cells, one of which was on the point of emerging. Another cell gave a beetle, uncolored, having just transformed from the pupa. The remaining cells (5) contained pupæ.

The species not being recognized in its larval stage, no examples were retained for the State Collection, nor description made of it, but several of the pupæ were preserved in alcohol. I have not found any description of the early stages of this insect, nor of its larval habits. Of the latter Dr. Thomas has written: "the larvæ, probably, like those of other known species (of Cetonians), live in rotten wood, as the perfect insects are often seen flying over chip yards, probably in search of a convenient nidus for their eggs" (4th Illinois Report, page 91). From the above, taken in consideration with the occurrence of the larva at Menands, it may be inferred that chip manure is its favorite habitat.

Do the larvæ feed also on growing vegetation? State Botanist Peck from whom the larvæ were obtained, had applied some of the manure to a few hills of corn in his garden. The following day one of the hills was noticed to have been cut down, as if by cut-worms. Upon digging around the stalks, two larvæ of the Euphoria were discovered, but no cut-worms, from which it would seem probable that the grubs had committed the injury.

THE ELAPHIDION OAK PRUNER.

The oak pruner, *Elaphidion villosum* (Fabr.) is not, I believe, of frequent occurrence on apple trees, but during the first week of June, its operations were very noticeable in an orchard in Voorheesville, Albany county, where a large number of twigs and branches had been thrown to the ground by it. Some of the branches brought to me were from three-tenths to seven-tenths of an inch in diameter. Each contained the mature and active larva, within a closed cell in its burrow, prepared for pupation.

The maple-tree pruner, *E. parallelum* Newm. (regarded by many as identical with the preceding species) was very abundant in early June in the maples bordering the avenues in the grounds of Governor Morton, at Ellerslie, in Dutchess county. Not a maple was seen which had not a score or two of the recently fallen pruned branches lying beneath it, although previous gatherings had been made and destroyed.

THE ASPARAGUS BEETLE.

The asparagus beetle, *Crioceris asparagi* (Linn.), is continuing its spread in the central and western counties of the State. In my Ninth Report, reference is made of its appearance at Geneva, Ontario county in

the year 1884, and at Rochester, Monroe county in 1892. On June 2d of the present year (1896), Mr. A. P. Case of Vernon, Oneida county, sent to me asparagus twigs bearing numerous eggs of the beetle, and shoots eaten by the larvæ. He writes: — "The insect has appeared since Saturday last (May 30th) on all of the asparagus beds here, where they have never before been seen. Every sprout is covered with the worms, and the new seedling shoots are alive with the full-grown worms, and newly hatched ones are burrowing into the stalks. The tops of the young shoots are alive with the mature worms which eat them off as they appear. The crop is worthless for this year." During the meeting of the Association of Economic Entomologists, at Buffalo, a further western extension of the insect within our State was brought to my notice, in examples given me by Mr. Ottomar Reinecke of that city which were collected by him August 20th from wild asparagus growing in the outskirts of the city.

[On June 2d, 1897, information was received of its abundant presence in a garden at Geneseo, Livingston Co., where it was attacking the young shoots as they appeared above ground, and destroying the crop.]

THE ASH-GREY BLISTER BEETLE.

The ash-grey blister beetle, *Macrobasis unicolor* (Kirby) was received (June 9th) from New York city, where it was reported as feeding destructively on a locust hedge. The young and tender leaves at the end of the branches had been eaten over the entire extent of the hedge of about 600 feet in length. They were driven away or killed when the pyrethrum powder recommended for them, was applied.

Examples of the same insect came June 25th from Factoryville, N. Y., where they were rapidly destroying the leafage of potato vines.

THE CHINCH BUG.

A correspondent from Almond, Allegany Co., writes that this insect *Blissus leucopterus* Say, is very thick on his new seeding and has ruined his pastures, and that it has destroyed his meadows for the past 4 or 5 years. They were working in the greater part of his 300 or 400 acres of land. Mr. Van Duzee, in his collections in Erie and Niagara counties the present year, has met with only a few scattered individuals of the species.

THE SAN JOSÉ SCALE.

The San José Scale, *Aspidiotus perniciosus* Coms., has apparently found the climatic conditions unsuited to its establishment in all except the extreme south-eastern part of our state. Its existence in a few localities has been reported to me, but in each instance another scale has been mistaken for it. At the Kinderhook locality where it was first discovered in the Hudson river valley, it has been nearly exterminated. Recently its presence was suspected by the owner of the orchard, Mr. Morrell, where it had been found abundantly two years ago, but on examination, the scale proved to be the rather closely resembling one, *Aspidiotus juglans-regiæ* Comstock. An examination of the orchard showed no living San José Scale, but later, a single living specimen alone on a twig, was brought to my office by Mr. Morrell.

A neighboring orchard in Kinderhook was reported as badly infested with the scale. On examination in July, by Mr. E. P. Felt, my assistant, the scale was found in abundance on plum trees of apparently ten or twelve years' growth, but upon perhaps twenty trees that were carefully examined, not a single living scale was found. The trees had not been treated for the scale, and it is therefore probable that the insect had been winter-killed. How long they had been upon the trees, or the source of the infestation, was not learned, but the age of the trees would indicate that the pest had not been introduced on nursery stock. The orchard was within one fourth of a mile of that of Mr. Morrell, and it is highly probable that it had been carried from there upon birds or insects.

The scale has also been reported to me recently (in August), from another locality in New York, in the valley of the Wallkill river—a tributary of the Hudson river. A few fruit-trees in an orchard in Middletown, Orange county, are stated to be infested with the scale—the trees having been received from a New Jersey nursery. Inquiry was promptly made of the owner of the orchard of the extent of the infestation with proffer of assistance if needed, but no reply having been received, it is probable that the infested trees were promptly destroyed, and that the spread of the insect was not feared.

THE OAK KERMES.

The peculiar oak-kermes, *Kermes galliformis* Riley (Pl. V, fig. 1), which bears so marked a resemblance to a gall as to be mistaken for it by everyone not acquainted with it, may not be rare when one knows where to look for it, but it has always been a rarity in my own experience. One of my cor-

respondents, Mr. W. R. Walton, of Middletown, N. Y., has been fortunate in his collection of it and has kindly contributed a number of examples to the State Collection. He also has been successful in breeding from it the beautiful Lepidopterous parasite, *Euclemensia Bassettella* (Clemens), with which it is so frequently infested and of which he has made excellent colored drawings in its several stages (Pl. V, figs. 2–7). From Kermes taken from scrub oak in the latter part of December, he obtained the moth toward the last of the following June. The larger number of the mature Kermes were found to be infested by the parasite.

THE ELM-TREE BARK-LOUSE.

Gossyparia ulmi (Geoffrey), an European Coccus, feeding on most of the varieties of the European and American elms, was first noticed in this country at Rye, Westchester county, N. Y., in June of 1884. (See Howard in *Insect Life*, ii, 1889, pp. 34–41). Examples of it were brought to me from Marlboro, Ulster county, in July of 1888. Since that time, it appears to have become distributed in different portions of the State, and to have planted itself in several localities in the vicinity of Albany. In May and again in June, it was brought to me from Loudonville, Albany county, and in June of the same year, from two places in the city of Albany, and also from Catskill, Greene county, 40 miles to the southward.

In June of the present year, Mr. J. B. Washburn, brought a limb of elm from his grounds at Delmar, Albany county, bearing dense patches of the Coccid. It was blackened to a degree that indicated the abundant presence of the insect the preceding year. The tree — a young one—of about three inches diameter of trunk, was infested both upon the trunk and the limbs. Other elms upon his grounds were not infested. The scales were apparently about full-grown, but no young had yet been given out.

A large number of trees in the city of Albany, are at the present time (in August), showing severe and injurious attack from this insect. The leaves are blackened by their secretions, and some of the branches whitened by their abundant presence. Their larvæ, about half-grown, are to be seen in large numbers in the crotches of the smaller twigs, on the lower surface of the leaves, and in the crevices of the bark. The infested trees are mainly the Scotch elm, *Ulmus montana*.

The insect is also quite generally distributed in Troy — six miles to the north of Albany, where in combination with the attack of the elm-

leaf beetle on *Ulmus montana*, it is threatening destruction to many of the trees. It also occurs at Menands and Watervliet, between Albany and Troy. The infested trees can be recognized at a distance by the blackened appearance of the limbs and foliage.

PHYTOPTUS ? PRUNI (Amerl.).

Leaves of a Chickasaw plum, received the middle of May from a correspondent in Muncy, Pa., had numerous mite galls scattered over their surface, on both their sides. On the lower surface they are of an elongate purse-like form, and give out from their sides some short white hairs resembling mould: on the upper surface they are rounded and completely covered with longer white threads. Within the galls, a powerful microscope showed a minute transparent four-legged mite — the architect — apparently in an early stage of growth. The mite, if we may judge from the characters of the gall that it produces, is identical with an European species, known as *Phytoptus pruni* Amerl., and which has not, we believe, been previously detected in this country.

(B)

ENTOMOLOGICAL ADDRESSES.

THE MOSQUITO.

[Read before the Dana Natural History Society of Albany, May 14, 1887.]

Strange as it may seem, the common objects in nature surrounding us on every side and ever at hand, are those of which we frequently know the least. Day after day throughout our lives many, if not most of us, pass along the streets without knowing the nature of the stones we tread upon, the names of the trees that throw their grateful shadows over our pathway, or of the birds or insects that fly around us. If the cultivated mind may find "sermons in stones, books in the running brooks," surely volumes of intense and absorbing interest are to be found in the interpretation of the vegetable and animal kingdoms, in their infinitely varied forms, their complicated structure, their wonderful transformations and peculiar habits: and how much do we lose from our inattention to these common objects — the almost constant presence of which before our eyes is a perpetual invitation to their observation and study, and a rebuke for their neglect.

I have chosen for my topic of this afternoon paper, one of these common objects—a very common insect, with which, perhaps, you may think yourselves sufficiently familiar, while, in reality, knowing next to nothing of it. And if I shall succeed in showing you that the mosquito, perhaps the most universally obnoxious of our insect pests, possesses many attractive features and has its beneficent uses in nature, you may feel inclined to extend to it henceforth some degree of toleration, and even to honor it with a little attention. Yet I shall not expect that even the enthusiastic members of the Dana Natural History Society will be wrought up to such a state of ecstasy in its contemplation that they will adopt the sentiment of a distinguished naturalist of the past century—"it is impossible to behold and not admire the amazing structure of the mosquito's sting: one undergoes with pleasure a puncture that enables us to observe how this wondrous piece of mechanism works."

The Common Name.

Mosquito is a Spanish and Portuguese word, and is probably the diminutive of the Spanish *mosca* fly. Its orthography varies, it being given by Webster as m-o-s-q-u-i-t-o, m-u-s-q-u-i-t-o, m-u-s-k-e-t-o. For

the last phonetic mode of spelling, I have a decided preference, and would gladly see it adopted were it not that the orthography approved by Webster of m-o-s-q-u-i-t-o, is sanctioned and sustained in its employment as the specific name of one of the species of the genus *Culex*, and scientists do not feel at liberty to change a single letter in a specific name once given and accepted, except under a few prescribed conditions. Another mode of spelling with which we sometimes meet, is m-o-s-c-h-e-t-o, the authority for which I do not know.

The common name, as is often the case with unscientific names, does not define the insect intended. The insects which in the United States are known as mosquitoes, are popularly known in England and also written of, as gnats. By some writers, the blackfly — the terror of the Adirondack tourist in early summer, has been claimed as a mosquito, while in reality it belongs to a family — the *Simulidæ* — quite removed from the *Culicidæ*. The Portuguese, in Brazil, are said to apply the name to a small species of Simulium or black-fly.

Its Place in Classification.

The mosquitoes and associated gnats belong to the order of Diptera, or two-winged flies, and to the family of *Culicidæ*, so named from its principal genus, *Culex*. This family from the high degree of development of its mouth parts, has been placed near the head of the Diptera, as are the *Cicindelidæ* or tiger beetles at the head of the *Coleoptera*. The principal characteristic of the family, is its long and slender beak or proboscis, nearly half as long as the insect, appearing as a simple organ, but really composed of several pieces, peculiarly fitted for their function of forcing their way into the flesh and drawing blood therefrom.

The mosquito, is not, as its popular name would seem to imply, a single species. There are a number of distinct and well characterized species, which have their special haunts, different degrees of annoyance, and different seasons of the year devoted to their forays. Even in that season when the entire insect world out of doors is generally supposed to be indulging in its sleep of months preparatory to its spring opening and summer campaign, we are not left wholly without representation of this intrusive family, for the winter months may bring us occasional visits — fortunately they are rare — from *Culex hyemalis*, the winter mosquito.

All of those which are grouped in the family of *Culicidæ*, may properly be regarded as mosquitoes, as they are closely allied in structure and in habits.

Number of Species.

Although exceedingly numerous in individuals, occurring at times in localities in swarms so immense that they have been mistaken for clouds or smoke, the *Culicidæ* are not very numerous in species. In a catalogue by Mr. Walker, formerly of the British Museum, published in 1874, one hundred and fifty-eight species from all parts of the world are given. Of these, the North American species comprise about one-fourth of the number, for in the last published catalogue, that of Baron Osten Sacken, in 1878, forty-two species are recorded as belonging to North America, arranged in the five genera of *Megarrhina*, *Culex*, *Anopheles*, *Aëdes* and *Corethra*.* The specific names that designate many of these have a merit that does not always attach to our scientific nomenclature — that of being appropriate and characteristic. For example, we find the following names in the list of species of Culex, each one of which we may presume, has been bestowed after experimental test of its fitness, as they lead us up the gamut by harmonious gradations from the initiative *Culex punctor*, to *pungens*, and on to *stimulans*, *perturbans*, *provocans*, *impatiens*, *implacabilis*, *excitans*, *excrucians*, and culminating in *Culex damnosus*.' The last is applied to the notable "gallinipper" of the southern swamps, which is said, but I do not vouch for the truth, to be capable of boring with its proboscis through a leather boot.

It is not probable that in the numbers above given, we have an approximation to the real number of species. The family, for some reason, has been but little studied. When I applied a short time ago to the gentleman who is the best authority that we have among us on the Diptera, for the names of a few of our more common species represented in my collection, he was unable to determine them for me. Another of our distinguished entomologists who enjoys a brilliant European reputation from his long residence in Europe could not decide the question which I propounded to him—does *Culex pipiens* of Europe, the type of the genus, occur in North America, to which it has been credited.

Distribution.

Every known part of the globe has its peculiar species of the mosquito. They are endowed with power to resist any degree of cold and to endure extreme heat. They particularly swarm in the tropics where they often

* Dr. L. O. Howard, in a paper published the present year (1896), has recorded twenty species of mosquitoes belonging to the United States, which had been examined by D. W. Coquillett, of the Division of Entomology at Washington, accompanied with a list of ten additional species, which had not been examined for verification. (See *Bull. 4, New Series, U. S. Dept. of Agricul., Division of Entomology.*)

render life a burden. In the frozen regions of the north where winter reigns, their numbers have been compared to a snow-storm when the flakes fall thickest, or to the dust of the earth. There are localities which they are entitled to claim as their own, for explorers have been driven back in agony from the attempt to penetrate them. To other localities they have given name, as to Mosquito, a township in Illinois; Mosquito, a village in Newfoundland; Mosquito Creek in Indiana, another of the same name in Iowa, and still another in Ohio; and the Mosquito Country of Central America. In certain districts of Louisiana and other of the Southern States, their abundance diminishes by one-half the value of the plantations. Those who have traveled in summer on the lower Mississippi or in the Northwest, have experienced the torment which these frail flies can inflict: at times they drive everyone from the boat, and trains can sometimes be only run with comfort on the Northern Pacific railroad by keeping a smudge in the baggage car and the doors of all the coaches open to the fumes. "The bravest man on the fleetest horse dares not to cross some of the more rank and dark prairies of Minnesota in June" (Riley). The marsh lands of New Jersey and portions of Long Island, you will remember are particularly noted for their abundance, and the frequenter of the Adirondacks knows of their powers of annoyance, as they compel him if particularly sensitive to their sting, to seek relief in flight.

It would seem that our English cousins have much less to endure from this tormenting pest than we, for Professor Westwood has written: "The mosquito is far more annoying in its attacks upon the inhabitants of America than our European species is to us; it is there requisite to have their beds inclosed in a curtain of fine gauze to defend the sleeper from their attacks." The Rev. Mr. Kirby, in his delightfully fascinating work entitled "Introduction to Entomology," after a graphic recital of the torments endured in various parts of the world from the mosquito's poisonous sting, and the inferential conclusion that it were "a lesser terror that the forest should resound with the roar of the lion or the tiger than with the hum of the gnat," closes with this pæon of gratitude: "With what grateful hearts ought the privileged inhabitants of these happy islands to acknowledge and glorify the goodness of that kind Providence which has distinguished us from the less favored nations of the globe, by what may be deemed an immunity from this tormenting pest!" Evidently the fogs of England and London smoke are not agreeable to the mosquito.

Means of Protection.

In that portion of the world which we occupy, and in the localities where this insect occurs in annoying numbers, comparative immunity from its attack is attainable by the use of mosquito nettings, but there are countries where these luxuries are not procurable, nor would their employment afford the desired protection. The inhabitants of some of the districts of Brazil, at certain seasons, can only obtain sleep at night by burying their bodies several inches beneath the sand, and covering their heads with a thick cloth. On the west coast of Africa the natives swing their hammocks from elevated posts with fires burning beneath them to repel the insects with the smoke and heat. In Guiana the poorer classes find a degree of protection in covering their bodies with paint and varnish. Russian soldiers in the neighborhood of the Crimea resorted to sleeping in sacks as a protection, but this served only as a palliative of the unendurable torments to which they were subjected by the attacks of the insatiable blood-suckers of that region. In Lapland, a writer states, that it is impossible to eat or sleep or keep a light burning in the hut without constant fumigation, and the additional resort to a coating of the exposed portion of the person with rein-deer cream, rancid fish-oil and tar.

For the benefit of those whose summer wanderings may lead them into the haunts of the mosquito, under circumstances when heavy gloves and veils and nets may not be conveniently worn, I would state, that when the annoyance becomes too serious to be longer borne, protection may be procured by making oneself disagreeable to the mosquito through means not quite so pronounced as that to which the Laplander resorts, but by applying to the hands and face a small quantity of oil of tar combined with a little carbolic acid. This is, perhaps, the best application that can be used, as a preventive of mosquito attack under conditions above named.

Severity of the Bite.

The effects of the bite vary greatly in different persons. There are those who are scarcely affected by it, and indeed are rarely bitten, either by this insect, the bed-bug or the flea, although in situations exposing them to attack and with their companions suffering from the infliction I have no explanation to offer for the attractiveness of some persons for these pests and the reverse in others, but it would seem that it might result from some peculiar emenation from the person, as no attempt is made to draw the blood or pierce the skin of those exempt from attack.

While in some, only a slight and brief irritation follows the bite, in others, the well-known itching sensation becomes intense, and is accompanied with serious inflammation and swelling which may be continued for several days. Again, the resultant effect of the bite often depends upon the general condition of the system at the time, and upon the particular portion of the person where it is received. I do not know of any fatal result attending the bite of a single mosquito, but we have a well-authenticated instance where death ensued as the consequence of the sting of a hornet inflicted in the scalp of a bald head.

When the occasional mosquito, which we find a trial, is multiplied a thousand-fold, the wounds against which the victim is powerless to defend himself, become a most serious matter. The swollen hands almost lose their service; the bloated face scarce admits of recognition. Mortification of the limbs has ensued, rendering amputation necessary, and cases are recorded where death has resulted. Professor Jeager relates that on one occasion when traveling on the banks of a river in Russia, his servant was driven to such a degree of madness by his sufferings from the dense cloud of mosquitoes in which they were enveloped, that he was only prevented from shooting himself as an escape from his misery, through the united strength of two athletic Cossacks.

The severe stinging sensation and subsequent inflammation and itching of the bite, is owing to a poisonous fluid injected into the wound through the proboscis at the time of its insertion to affect the blood and cause it to flow more readily. This opinion, advanced by Reaumur long ago, was for a long time held as probable. Very recently, however, it has been verified, by Dr. Macloskie, of Princeton College, New Jersey, in the discovery of two poison-glands, the duct through which it is conveyed into the hypopharynx and the escape of the fluid, in oily globules from an aperture near the tip of that organ which is subapical like that in the rattlesnake's fang, so as not to weaken or impair the delicacy of its point.

Of the effects of this poison, and the reason for believing in its existence before it had been demonstrated, Dr. Dimmock, has written as follows: "After having experimented a large number of times with the living mosquito, I am convinced that there is use made of a poisonous saliva; for, when biting, if the mosquito fails to strike blood, which it often does on parts of the back of my hand, although it may have inserted its proboscis, nearly full length, in from one to six directions in the same and withdrawn it, yet, in such cases, if no blood be drawn, no more effect is produced upon my skin than is produced by the prick of a sharp needle — a red point appears only to disappear in a few hours. Certainly there

has been as much tearing of tissues in such a case as the above mentioned, as there is, when Culex settles on a place rich in blood, and, with a single probing, draws its fill. The amount of poisonous effect upon me, as proved by numerous experiments, is in direct proportion to the length of time the Culex has occupied in actually drawing blood. The above-mentioned facts would indicate a constant outpouring of some sort of poisonous fluid during the blood-sucking process."

Palliatives of the Bite.

Various applications have been recommended and are employed to alleviate the effects of the bite, such as vinegar, lavender water, salt and water, spirits of camphor, ammonia, etc. Pressing the puncture and forcing out some of the blood, and with it the injected poison, has also been prescribed, but beyond doubt the best method that may be adopted is the following: When the bite is first felt, resist the natural impulse to crush the creature and stoically endure the trifling pain, while you add to the stock of your entomological knowledge by critically observing the extreme delicacy and the entire *modus operandi* of the performance, particularly noting the disposition made of the sheath while the contained case of instruments are being buried in the flesh. A brief period of forbearance will suffice to fill the abdomen of the skillful phlebotomist to its utmost capacity—the gradual enlargement and the deep purpling of which through its thin and distended walls you may watch. The fill obtained, the lancets will be leisurely withdrawn and repacked in their case, and with the prolonged draught taken through them most of the injected poison will have been withdrawn. If you are not able at this juncture to say with Sterne's Uncle Toby, "go, poor insect, the world is wide enough for you and me," then, if your study has failed to repay you, revenge yourself in her death as she assays with her stolen burden to fly slowly away. If you terminate her existence while the lancets are buried in your flesh, their barbed ends together with most of the poison will remain in the wound to irritate and exact of you the penalty of a wasted opportunity and an unscientific proceeding. You might, at least, if you feel that you have no contribution to make to Madame, intimate to her by a gentle touch of the finger, that it would be quite as agreeable to you if she would present that little bill somewhere else. A million lessened by one, would aid but slightly in the extermination of the species in your immediate vicinity.

The Female only, Bites.

I would not be thought as reflecting in the slightest — even through innuendo — upon the gentler sex — "Heaven's best gift to man" — without whose presence Eden was incomplete; but a proper treatment of my topic and inexorable science demands of me the statement to which the use of the feminine pronoun has been leading me up and preparing the way, to wit: all the annoyances, pains, tortures, which the world endures from the mosquito, is solely chargeable upon Madame Culex. I cheerfully admit that the natural taste of Mr. Culex may be equally blood thirsty, but alas, poor creature! he has been left without the means of gratifying a sanguinary desire. He is, therefore, compelled to forego the exquisite relish of the royal repasts in which his consort finds so great delight, and be content with the juices of plants and the nectar of lilies, and of other flowers to which he is particularly addicted. He has not been favored by nature with that delicate and complicated piece of apparatus which is so admirably adapted, as has been graphically expressed, to being driven "through crushed and bleeding capillaries, shrinking nerves and lacerated tissues." With a becoming humility, therefore, he rarely visits us in our apartments, or even obtrudes his presence upon us when we seek his haunts; and few of us know of the branching plumes, fit for a knight, that adorn his front and make him far more beautiful than his unpretentious mate.

The Biting Organs.

By this time you may desire to be told something of the character of the biting organs of which the effects have been related to you.

Let me preface by stating that the mouth-parts of insects consist, normally, of six pieces, viz., four lateral pieces consisting of a païr of upper jaws denominated *mandibles*, a pair of lower jaws named *maxillæ* (which in biting insects that feed on solid matter move horizontally), an upper lip known as the *labrum* and the lower lip, the *labium* — these two covering the mouth from above and beneath. Some of these bear appendages which need not at the present be referred to. These organs, of course, are greatly modified in the different orders of insects, to adapt them to the different methods of taking their food — whether fitted for gnawing or tearing in pieces solid substances, as in the beetles — transformed into a sucker with expanded disc for sipping its food as in the house-fly — extended into a long, flexible tube coiled up in a spiral when at rest, for drinking the nectar from the bottom of tubular flowers, as in the butterflies, or forming a long, firm, jointed proboscis for thrusting into plants or

animals through which to draw their juices, as in the Hemiptera or bugs. These parts exist in all insects, although at times some of them may be but rudimental. The mouth-parts of the female Culex represent all of these typical parts of different insects, and in the formation of its proboscis, two other organs unite (as in most of the Diptera) which are the pharyngeal sucking organs, named the *epipharynx* and the *phyopharynx*.

It therefore appears that the proboscis of the mosquito, which in its normal condition seems but a single piece, upon dissection or close examination is found to consist of seven distinct pieces—eight pieces in reality, but two so combine as to form one. Some authors have stated the number of pieces at four, five, or six, but there certainly are as many as seven in *Culex pipiens*, *C. ciliatus* and *C. rufus* which have been carefully studied, and it is not probable that the number will be found to differ in other species when examined.

These pieces are shown in the accompanying figure. The upper piece, pointed and gradually tapering from the base to the apex, is the *labrum-*

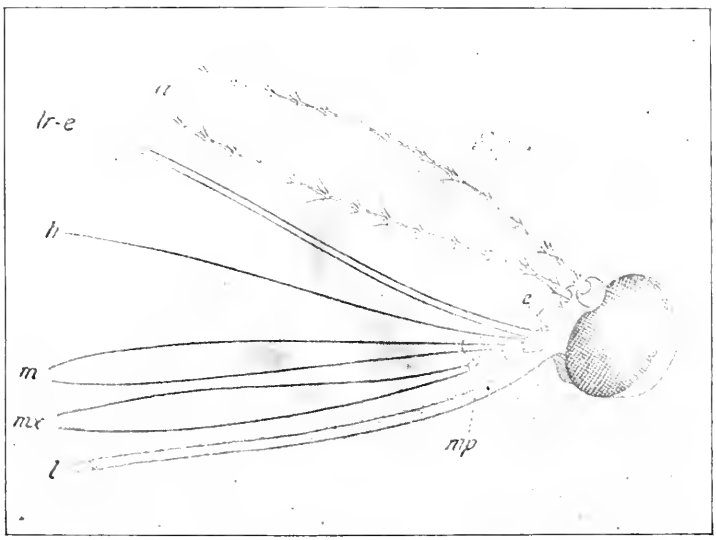


Fig. 9.—Mouth parts of the mosquito, lateral aspect. (After Dimmock.)

epipharynx, made up by the close union of the *labrum* and the *epipharynx*. Below it is the *hypopharynx*, a linear, lanceolate, transparent plate, having a longitudinal rod (appearing as if tubular in some species) traversing it in the middle, through which, it is thought, the poisonous fluid which we

have referred to is conveyed into the wound. With these two pieces pressed together, a channel is formed through which the blood passes as it is pumped up by the sucking-bulb, located in the head. The mandibles are the most delicate of the mouth-parts, consisting only of thin, linear-lanceolate blades of transparent chitin, slightly tapering in their width from their base outwardly. The existence of very fine serrations on their upper part (about forty-two on each) has lately been announced.*

The *maxillæ* are tapering, transparent blades of chitin, thickened on its upper edge and apparently toothed or serrated at the tip. Careful observation with a powerful microscope shows them to be not serrated at the edge, but the apparent teeth—about fifteen near the tip of each, are really papillæ placed on the upper surface of the blade. Aided by these papillæ, the service performed by the maxillæ is doubtless to draw the other mouth parts into the skin, as a slow gliding motion may be observed in first one and then in the other as all the parts are gradually buried. They are provided with muscles appropriate for the purpose.

The *labium* is the largest of the mouth-parts. It opens along its upper side in order to receive the other parts and to serve as a sheath for holding and protecting them when not in active use. When the proboscis is to be inserted, it acts in this manner: Its tip, consisting of two lobe-like appendages called *labellæ*, is closely pressed upon the surface. At once it is seen to bend backward or downward at the middle, releasing the contained parts—the setæ—which are held firmly together as they are driven into the flesh, guided and kept in place by the above named *labellæ* serving as a pair of fingers for the purpose. As they penetrate deeper and deeper, the labium or sheath bends more and more until when they have been buried to nearly their entire length — from having been at first elbowed, it is now bent double beneath the body.

The operation as above described is an exceedingly interesting one to watch. The labium is easily recognizable in any female mosquito that you will examine, appearing as a long projected beak, nearly as long as the abdomen, clothed with dark colored scales, and extending in front of the two delicately feathered antennæ given out from between the two large black eyes.

The relative position of the mouth-organs which I have briefly described, and the manner in which they are arranged in the sheath, may be

*American Naturalist, xxii, 1888, p. 884.

understood from an examination of the accompanying figure, which represents a transverse section through the proboscis of the female at about its middle.*

The labium is seen wrapping itself nearly around the other parts. Above it lie the two maxillæ, partly inclosing the parts above it. Above them are the two mandibles, and above these, centrally, is the hypopharynx, with its thickened, middle, supposed saliva, channel. Above this is the labrum-epipharynx — the epipharynx of an omega-form, having the labrum closely attached to it. With the labrum-epipharynx slightly brought from its position as shown for convenience in the figure, so as to rest on the hypopharynx, the channel for the passage of the blood, as has been described, is formed. In the continuation of this sucking-tube into the head, "in the posterior part of the head, it is enlarged in a large pumping-organ, which forces the imbibed fluid backward into the œsophagus and stomach" (Macloskie).

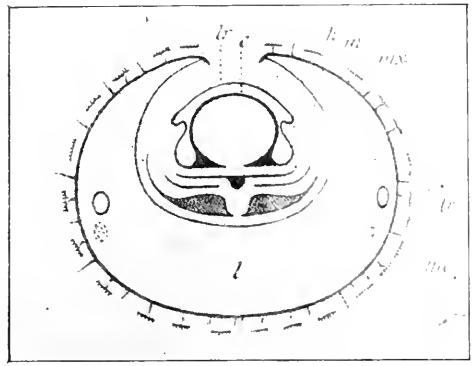


Fig. 10 —Mouth parts of the musquito, cross-section. (After Dimmock.)

Uses of the Mosquito.

I have spoken of the mosquito as the most universally annoying of all our insect pests. Why then, it may be asked, was it created, and does it serve any possible good in the economy of the world?

The naturalist, as his acquaintance with nature becomes more extended, and the range of his studies widens so as to open up to him an insight into the interdependence of all animated nature, is led to accept the belief that nothing was made in vain, and that not a single one of the typical forms now in existence could be withdrawn without breaking the chain that binds all nature together in one harmonious (if properly interpreted) whole. This belief brings to him a faith that compels him to accept as of use whatever object owes its existence and preservation to the hand of its Creator and Guardian, although in his limited knowl-

* This and the preceding figure are copied from Plate 1 of *The Anatomy of the Mouth-parts and of the Sucking Apparatus of Some Diptera*, by George Dimmock, Boston, 1881.

edge, he may not be able, in all cases, to assign the purposes for which it was made.

Do not misunderstand me. I do not object to the destruction of noxious animals when our lives are endangered by them, nor to a very great reduction — even to the extreme extent of our ability — of the overwhelming numbers in which some of our insect enemies present themselves, depriving us of comfort, withholding from us luxuries, and robbing us of material wealth and at times of the necessities of life. To such a reduction, my studies and labors as you know, are being constantly directed. But it is only against excessive numbers that the economic entomologist contends — an excess that did not exist when first "God saw that all was good" — which could not exist under the operations alone of the laws of nature, but which do exist as the result of the unnatural, excessive, and often improper demands of our present form of civilization and society. Briefly, it is right and proper to restrain; it would be wrong, we think, had we the power to utterly exterminate.

But to return to the question. We do know one purpose which the mosquito serves, and one of considerable importance in a sanitary point of view. It serves to purify standing waters and to a great extent to lessen their malarial influences. The natural habitat of the larval mosquito is the stagnant water of our miasmatic swamps. The entire food of the creature from its birth to its maturity is believed to consist of the decaying vegetable matter which is here found in abundance, together with other impurities which it draws from such waters. Its agency in the purification of standing water may be easily shown. If during the summer months two barrels of rain-water be placed side by side — the one open to the atmosphere and the other covered with a thin netting, the following result will be obtained: The open one, after a few days has elapsed, will be found to abound with the larvæ and the pupæ of the mosquito, and its water sweet; the other, the netting of which prevented the visits of the mosquitoes for the deposit of their eggs, and consequently without larvæ, will have become foul and offensive.

We need not refer to an important role which the insect in its superabundance plays, as food for fishes, since that is but in accordance with a seemingly universal rule controlling all of the lower orders of animated nature, viz., "eat and be eaten."

In view of this general law, seemingly fraught with so much suffering, how fortunate it is, we may remark incidentally, that many of the lower orders which are doomed to a perpetual sacrifice to the Moloch, appetite — insects, for example — have organisms so constituted that they are

almost without a consciousness of pain. Thus the rapacious dragon-fly — the hawk of the insect world — would quite as readily eat its own abdomen, as actual experiment has shown, could it conveniently be brought within range of its powerful jaws, as to indulge in its favorite and ordinary mosquito diet.

Newspaper authority — not always the best in matters of science — has lately (last year) given us another mosquito "boom," in the announcement of the discovery that the Cuban mosquito was about to signalize a great advance in the science of Therapeutics — to serve no less a purpose than an effectual preventive of the fearful disease of yellow fever. The method of protection was simple in the extreme. A bottled mosquito must be applied to the person of a yellow fever patient and permitted to imbibe a little of his blood. Transferred, after a few hours, to the arm of the individual to be protected, the virus received would be conveyed with or through the proboscis, and a successful and complete vaccination against yellow fever will be accomplished.

The Mosquito as a Filaria Host.

If the above be only a fanciful conception of some "newspaper man," as it possibly may be, the fact that the mosquito may communicate disease, or aid in its distribution, rests on a scientific basis. Some recent anatomical investigations of a species known as *Culex mosquito* inhabiting tropical regions, have shown it as serving a most unexpected purpose in acting as an intermediary host in the life-development of a thread-like worm,—a species of *Filaria*. This hæmatozöon, bearing the name of *Filaria sanguinis-hominis*, is found in its immature or larval stage in the blood of persons afflicted with elephantiasis and some of the allied diseases which are endemic over the more thickly populated tropical portions of the world.

Before the filariæ can undergo their full development they have to enter some other organism quite different from that occupied by their larvæ. The female mosquito above named (and probably other species also) acts as the host in this instance. As she drinks the blood of the diseased person, she imbibes with it the larval filariæ. Within her abdomen they undergo further transformations. Six distinct stages have been recognized within her. As she returns to the water for the deposit of her eggs—with her death occurring soon after oviposition, the filariæ which she bears in their perfected stage, are consigned to the water. In drinking the water, the parasites are received into the human stomach, from which they pass to, and enter, the lymphatic vessels, and by their

presence, under suitable conditions, produce the painful, loathsome, and often fatal disease of elephantiasis. (See Science, for May 18, 1883, i, pp. 419-420, for an extended notice and illustration.)

The Mosquito Perhaps One of the Ten Plagues of Egypt.

Professor Westwood, of London, an eminent entomologist, and the author of a volume on insects of such exceeding value that it is known as "The Entomologist's Bible," has endeavored to show that the mosquito was the insect that composed the "swarms of flies" that were sent upon Pharaoh and his people as one of the *ten plagues of Egypt.* In evidence of this, he cites the expression "swarms of flies," and remarks: "We are sure that every one who has seen a swarm of gnats at eventide, will perceive the aptness of the expression, supposing the Egyptian fly to be a species of gnat, or in other words, the mosquito. We next read of their making their way into the houses, which shall be full of flies. This is also precisely the habits of the *Culicidæ.*" The distinguished Doctor of Science (like an eminent Doctor of Divinity of our own city), evidently favors "a reduction of the miraculous in the Bible to the minimum," and a non-resort to a miraculous interpretation of such phenomena as may be explained by natural causes; for he finds the fullest corroboration of his view of the mosquito being the plague insect, in the fact that the land of Goshen, in which the people of Israel dwelt, was to be exempt from the swarms of flies that invaded the land of the Egyptians. The latter, he remarks, was subject to a periodical overflow of the Nile—a condition most favorable to the production of mosquitoes; while the land of Goshen, was not overflowed and was a sandy soil entirely unsuited to the mosquito, and even at the present time, a favorite place of refuge for cattle from its attack.

Others, who have written of this plague, entertain different views—among which, Rev. Mr. Kirby, finds strong evidence of its having consisted of cockroaches. Opinions might differ as to which would be the greater plague.

Eggs of the Mosquito.

The transformations of the mosquito, to which we now pass, are of much interest, as I hope to be able to show you.

While the eggs of a large proportion of our insects, either from their form, color-markings, sculpture, or manner of deposit, offer many attractive features, those of the mosquito possess special and unusual interest from the singular disposition made of them.

The individual egg is of an elongate-oval form, rather pointed at the upper end, broader at the lower. They are deposited in a mass, on the surface of the water, in the form somewhat of a boat, and left to float freely about. The little egg-boat, not exceeding a tenth of an inch in length, yet bearing nearly a hundred lives, is built in the following manner: The insect takes her position on some object in the water—a floating leaf or stick it may be—holding to it by her anterior legs, while her long abdomen rests on the water with its tip slightly elevated. Crossing her posterior pair of legs (which are much longer than her body) behind her in the form of an x, she places an egg in a perpendicular position at the point of crossing—the inner point, nearest the tip of her abdomen: this forms the keel of the boat. To this two eggs are next attached in the form of a triangle. The eggs are coated with a glutinous matter, causing them to adhere closely and firmly to one another. Successive additions are made to these in a gradually enlarging outline, as regulated by the angle or curve formed by the legs. When the boat is about half built, the legs are uncrossed and placed side by side underneath for better support, and in this position the remaining portion of the boat is completed in a symmetrical form, although unaided by the eye and only guided by the delicacy of touch. When finished, the supporting legs are withdrawn, and the tiny craft is launched, and left to be driven about hither and thither by the winds, yet ever drifting securely, without the slightest risk of sinking to the bottom or of being overturned. For experiment's sake, you may place one in a basin of water and pour gallons of water on it, without being able to overturn it. You may even thrust it by force to the bottom of the vessel, whence, as soon as released, it will rise to the surface, right side up and not holding in its concavity a particle of fluid. It is a veritable life-boat.

The Larval Mosquito.

The eggs hatch ordinarily in from two to three days, dependent, of course, on the temperature of the water. The larvæ that they produce are familiar to all who have been in the habit of using rain-water during the spring or summer months which had been exposed to the open air for a few days. Children living in the country often know them under the appropriate names of "wigglers" or "wrigglers," drawn from their peculiar jerking motions as they come to the surface of the water to draw in a supply of air and to hang motionless, head downward, for awhile, or with the same motion descend to the bottom to feed. They have a distinct rounded head with mouth-parts, antennæ and ciliated ap-

pendages, an enlarged thoracic region, and a long ten-jointed abdomen, slightly tapering, with each segment bearing bundles of hairs. From the eighth abdominal segment a long tubular organ is given out, ending in a star-like structure bearing a number of ciliæ. This is its organ of respiration—all the air that it receives being supplied to the tracheal vessels only through this opening. The terminal joint of the abdomen bears five conical plates which are used in its locomotion.

The Pupal Mosquito.

After several moltings, while they rapidly increase in size, the larvæ enter upon their third stage of existence, in assuming the pupal stage. At this time they present an uncouth aspect. Their thoracic region has become greatly enlarged, and in front of it are grouped, in separate cases, the legs, wings, mouth-parts and antennæ. They still continue in an active state, unlike the quiescent pupal condition of many insects, and even many other Diptera — but they are incapable of feeding. A striking and interesting change has taken place in their breathing apparatus. They suspend themselves from the surface of the water, as before, for respiration, but the air is now taken in through two horn-shaped organs proceeding from the upper part of the thorax. Before, they hung head downward; now, as they have made a material advance in development, more fittingly, head upward.

In about two weeks, usually, from the deposit of the eggs, the pupal stage is completed, and the insect is prepared to enter upon its final state, a perfect, winged insect. With so brief a period required for its development, you will perceive that there is ample time for several generations of the insect during the spring and summer months.

The Final Development.

The pupa having fully matured, it rises to the surface of the water where it floats with its thorax elevated above the surface. Exposure to the air dries the exposed portion, and, aided by movements within, it splits along the middle line, and the head and thorax of the inclosed insect are thrust out. Slowly the wings, legs, other organs and abdomen are drawn forth through alternating muscular extension and contraction—all the while balancing itself in an upright position with the utmost care, for the problem of how to maintain the center of gravity when elevated so high above its frail and unstable base must necessarily be an exceedingly difficult one—it would seem to be an impossibility. The slightest

excess of lateral deviation, either from defective instinct or from a current of air, is at once fatal. The float—a mere transparent film—with its occupant, is thrown upon its side; the wings are wet and no longer serviceable, and the new life just opening, is ended. This fatality is common—indeed it is represented as the rule—the contrary, the exception. Each such occurrence, although a tragedy, need not evoke our sympathy although so oft repeated. Food is thereby furnished fishes and other living forms, and there will always be quite as many mosquitoes left as are required for sanitary uses.

With those that are so fortunate as to escape this perilous evolution, a short time suffices for the expansion of their wings through the entrance into their veins of air and blood, and to dry and fit them for flight. Just the manner in which the pupal-case is abandoned, is not definitely known; it may be with the feet resting upon its edge; or it may be as represented in some illustrations, that, carefully preserving its equilibrium, the insect bends forward and rests with its fore-legs on the water—a moment passed, perhaps, in admiration of the delicate form mirrored therein—when the wings are spread, and with their rapid vibration of five hundred beats a second emitting music though familiar yet not sweet to human ears—it launches forth into its new element, in quest, as it may be, of nectar, or of blood.

The mosquito is gone! Are you not glad, for with her flight ends my paper.

[Those who would like to consult some recent publications and studies upon this interesting insect are referred to the following:

HOWARD: in Bull. 4 N. Ser., U. S. Dept. Agricul., Division of Entomology, 1896, pp. 9-24, figs. 1–4.
LUGGER: 2nd Rept. Entomol. St. Exper. Stat. Minn., 1896, pp. 182–195, figs. 152–158.
OSBORN: Bull. 5 N. Ser., U. S. Dept. Agricul., Division of Entomology, 1896, pp. 25–30, figs. 1, 2.]

A PLEA FOR ENTOMOLOGICAL STUDY.

[Read before the Agassiz Association of the State Normal College, Albany, May 18, 1894.]

The Association which I have the honor and privilege of addressing, I have the right to believe, from its connection with an institution which, in the annals of education, has won an enviable reputation for the careful, systematic and thorough training it aims to give to all its pupils — is not only desirous of promoting to the extent of its ability investigations in various departments of Natural History, but that it is also able to do excellent work and render good service toward this desired end.

I therefore esteem it a privilege to appear before you to-day, and ask your earnest co-operation in that department of study in which I am specially interested, and to which so large a portion of my life has been devoted. I appreciate, to some degree at least, the almost infinite extent and variety of the Museum of Nature. On every hand and in every direction, objects of interest invite our observation and study. Excluding what lies beyond the sphere upon which we dwell — there are the rocks to which we owe our basis for study, and their contained fossils, telling of the forms that peopled this globe eons of ages ago; the vegetable world instinct with life and beauty and wonderful processes of growth and development, and crowned with the dignity of being the agency through which alone, directly or indirectly, existence is possible for each and every mammal, bird, reptile, fish, insect, myriapod, crustacean, worm, mollusc, protozoan — of all the myriad living forms that people our globe.

In each of the several classes of the mineral, vegetable and animal kingdoms, there is abundant work for the earnest student. There are collections to be made; elements, form and structure to be studied; habits to be observed; preparations for study and for preservation; comparisons to be instituted, forms new to science to be detected and illustrated; descriptions to be drawn and published, and name and systematic place to be given to each and every one.

Why, then, should I make a special plea for the study of the Insect world? I would not presume to do so, unless I felt that I could give you sufficient reasons for making the claim; of these, I offer,

I. The Mental Discipline that the Study Affords.

This should especially commend it to the young student, where the intellectual faculties are to be developed and strengthened, and the mind

guided and formed into proper habits of observation, thought and expression. To these ends, I believe entomological study to offer better discipline than the study of mathematics or the classics to which so much time is devoted and far beyond what may, by any possibility, in a large majority of students, be of any material practical importance.

But why may this be accomplished through the study of the insect world, better than by some other branch of natural history? We answer: because of the greater number of objects that in a given time may be brought together for study — the insect world presenting, as it does, by far a larger number of species than all the other classes of the animal kingdom combined. With this almost boundless number of species, it follows that there must often be but minute differences between them, not perceptible but through careful comparison, and often demanding the microscope for their detection. It is impossible that any one who has made a collection of insects of considerable size — separated them in their usually accepted seven orders, named such as he has been able to with the literature at his command or by comparison with other scientific collections, and arranged them systematically in proper cases, in their families, genera, species, and varieties — could have done this without having greatly strengthened his faculties of observation, comparison, discrimination, memory, and having acquired habits of study, industry, delicate manipulation, order, neatness, precision, and the like, which shall serve him in whatever position in life he may be placed, and cling to him to his life's end.

II. The Facilities for Entomological Study.

The entomologist, if unable to search for his material — we will not say, if not caring to seek it, for a lazy naturalist would be an anomaly — may have abundant material come to him unsought. As he walks the street, "the shard-borne beetle with its drowsy hum" flies in his face or alights upon his clothing; the moth sits at rest upon a tree-trunk or fence-paling as if asking for admiration and capture; the caterpillar drops upon him by its silken thread from an overhanging branch, or exposes itself as it travels over the sidewalk, to his meditative downcast gaze. Rapt in study in the seclusion of his room, the sudden thrust of the sharp lancet of *Stomoxys calcitrans*, causes its capture and invites examination of the curious projecting blood-sucking apparatus which, without critical observation, seems the only difference between it and the harmless common house-fly; or, curiously plumed creatures of delicate forms and colors, attracted by the light upon his study-table, will flit over his paper to mar

his penmanship and perhaps end their life in a bath of ink, as they are doing at this present while writing of their obtrusiveness.

The invalid, who may be held a captive within his home through physical weakness or other infirmity, during the months when the insect world holds its hey-day in the fields and forest, may still make ample collections for study and enrichment of his cabinet even within the confines of his chamber. Should the year be favorable for insect life (the years vary greatly in this respect), at least five hundred species could be taken by him. Does this surprise you, as an indoor collection for a single year? I believe it a moderate estimate. To many of you, perhaps, all the flies of our window seem alike, or the smaller forms are regarded as the young of the common house-fly. Yet I would engage that from the windows of a single room of one's house, during the months of March to November inclusive, there could be taken one hundred species of Diptera alone.

Insect collections are easily made, and with simple and inexpensive material. For our ordinary walks in the requirements of business or study, the "cyanide bottle," that comparatively recent invention, yet now regarded as indispensable to the collector—is all that is needed for securing most of our insects. To the cyanide bottle, of a size convenient to be carried in a pocket, should be added a small tin box for inclosing caterpillars or other larvæ, with some of their food if desired to rear them. For field excursions, we would multiply our bottles and boxes, and add a suitable net, a pin-cushion with insect pins of two sizes, and a box hanging from a button or belt in which to pin the collections.

III. The Interest Attaching to the Study.

I dare not urge this topic as I feel to do, for fear that you would receive what I might say as the extravagance of enthusiasm. If not prepared to accept the assertion, that in no department of natural history can you find so much to interest you, and to interest you so deeply, as in the study of insects, their transformations and their habits, then, if willing to test the truth of the assertion, will you please accept for guidance the following program:

Get the cocoons of some one of our larger silk-spinning moths, of the family of *Bombycidæ*,—let them be, if you please, of *Attacus Promethea*, which you may find at the present time upon your lilac bushes, infolded in dried-up leaves of last year's growth. Before you cut the cocoons from the twigs (you can hardly tear them off by hand) first observe the silk extending from the cocoon, enveloping the leaf-stalk and then encir-

cling the twig, binding the leaf securely to it, and holding it there during the falling of the other leaves and through all the winter's storms. Inclose the cocoons in a box of sufficient size to admit of the expansion of the wings of the moth and some freedom of motion when it comes from its cocoon. On some morning in the month of June, (earlier if they have been kept in a warm apartment) if your cocoons contained living pupæ, you will find that the moths have emerged, and deposited a large number of eggs, cementing them to the sides of the box. Note the regularity of form and size of the eggs, each with its yellowish spot upon its somewhat flattened upper side. When two or three weeks thereafter, the eggs commence to hatch, with a magnifier in hand, watch the enclosed caterpillars eating their way out of the shells, always at one side, and through a somewhat oval hole.

Transfer them carefully to some tender leaves of their food-plant, and observe their social habit of grouping themselves side by side like soldiers on parade, and their manner of eating. After you have watched them for a week, and noticed perhaps with fear of the result lest it should betoken incipient disease, their fasting for a day or two, you will find them materially increased in size and in a new dress of light green with bands of yellow, bordered with black, and rows of white-bristled tubercles studding their body. This is their first molting, or casting of their skin to admit of increased growth. Four or five times you may observe a similar molting, followed each time by a new and more beautiful garniture. As the caterpillar approaches maturity you will surely be compelled to regard it as a beautiful creature, with its creamy pruinescence, its bands of dark blue tubercles on each ring, its four rich coral-red horns on the front of its body and a yellow black-ringed one at its other extremity. Carefully observe the row of spiracles or breathing pores upon the sides of the body through which the air is admitted to the tracheal vessels, and the peculiar structure of its many-hooked clasping legs. It is indeed a wonderful creature,— not "a worm" as ordinarily stigmatized, but a being which its Creator has dignified with the possession of eight times the number of muscles that are to be found in the human body; and in every way worthy of your study and admiration. When through your watchful care, your little colony have attained their growth, to your great relief from providing them with an adequate supply of their daily food, do not fail to have your eyes upon them as they throw out the first threads that are to bend the leaf in shape for enfolding their cocoons, preparatory to passing to their pupation. The leaf may hardly be more than marked as the chosen one, before you may see the busy

spinner leaving it, and commencing to cover the leaf-stalk with a firm envelope of silk, which, when completed, will be stronger than you can break without forcible pulling. You will now be given a favorable opportunity as the caterpillar's head sways from side to side, to note the two silken semi-fluid threads emitted from the pair of projecting spinnerets beneath the mouth, but uniting and drying at once in a single thread. The intelligence that leads the caterpillar next to bind securely the enveloped leaf-stem to the twig by throwing band after band abou it, and in the event of the twig being a delicate one and liable to be broken off, then, in addition, securing the twig by the process above mentioned to its parent stalk — can not fail of amazing you. Do you think it simple instinct, working in one unvarying line inherited from its ancestors, and incapable of adapting itself to different or changed conditions? Then try the experiment that I once made, and learn your error. When all of this preparatory work has been completed, each lashing examined over and over again, and finally pronounced all right by its artificer — then with a sharp blade of your knife, quietly and neatly sever the leaf-stalk just where it is bound to the twig and, replacing it with accurate adjustment, insert a fine insect pin to hold it in place. You will not have long to wait before the spinning of the cocoon will be arrested and a reconnoitering expedition commenced. Your treacherous work is discovered as soon as the point is reached. The situation is at once taken in — the danger, the necessity of meeting it, and how best to do it, fully comprehended. You may not read in the microscopic eyes of the caterpillar, the successive phases of anxiety, alarm, distrust, annoyance, anger, resolve, triumph, but you may see him apply himself to the task of lashing anew the foot-stalk to the twig and thus bid defiance to your perfidious pin, around which he throws his silken threads, until the severed stem is stronger than before. What else is this than reason!

The shaping and formation of the cocoons will be of interest to watch, until the thickening walls have hidden the larva from your view. During the winter, you may sacrifice one or more of the number by making sections of them, that you may observe the structure of the double cocoon — one within the other, with the intermediate loosely-threaded non-conducting air-chamber, and the contained pupa, with its wing, leg, and antennæ-cases folded upon its breast, and the cast-off caterpillar skin compacted in a pellet behind it.

Your study of this life-history will not be fully carried out to its proper completion until, in the following spring, you can see the moth emerge from its cocoon. A strange looking object will it seem in your eyes, as with a brisk movement of its legs, it clambers upward to some position where its unexpanded wings may hang downward, limp and wet, over its

back. Watch the gradual but rapid expansion of the wings, as they grow before your eyes — the two membranes of which they are composed steadily distending as the circulation from the body is forced into the veins that lie between. The innumerable wrinkles of the membranes are smoothed out; the scales that are implanted in them also increase in size, until within perhaps half an hour the wings have assumed their full development, and display their perfect ornamentation, in patterns resulting from the combination of nearly half a million of individual scales — the most delicate imbrication that may be found in nature, and far surpassing any thing that art can produce.

If not deterred by my long recital you will undertake what I have proposed—to follow out the life-history of one of our silk-worms, and having done so, if you do not find that the study has been one of surpassing interest, leading you to further study of the kind, and wedding you to entomology—then you have been given or have acquired a nature that I can not comprehend.

IV. The Practical Importance of the Study.

It is universally conceded that Agricultural pursuits form the basis of National prosperity, and that upon the products of the soil our existence is dependant.

The existence of the insect world also depends upon vegetable life: hence arises that constant antagonism of man to the insect world, which becomes so intensified when through his agency as a cultivator of the soil, there results excessive multiplication of injurious species preying upon crops which he deems essential to him.

Every crop grown is exposed to their attack. It has been estimated that there are upon an average, six species of attacking insects to each known plant. From their minute size and the secrecy of their depredations, we can not fence them out, as we do our large domestic animals. Probably there is no cultivated crop which is not lessened by one-tenth through insect injury. Often there is a diminution in yield of one fourth; frequently of one-half, and at times there is a total loss, as when during the prevalence of the wheat-midge, forty years ago, entire fields of wheat were left uncut in New York and other of the wheat states, and for a term of years wheat could not be grown. In one year, in our State (1854), the loss from this tiny insect was calculated at fifteen millions of dollars. Illinois suffered in a single year, in its wheat and corn crops, to the amount of seventy-three millions of dollars, according to estimate, from the ravages of the chinch-bug (*Blissus leucopterus*). True, these were exceptional years, but from another insect pest, the cotton-worm

(*Aletia argillacea*), annual losses to the cotton-crop of the Southern States are sustained, it has been calculated, of thirty millions of dollars.

From careful computations based upon the census returns of agricultural products of the United States, the startling aggregate is presented of an annual loss in these products of three hundred millions of dollars.

A large proportion of this loss — this onerous tax upon industry — need not be sustained — need not be exacted. It is preventable through the use of means which have been and are being indicated by those who have undertaken the study of methods of prevention and remedy. In consideration of the progress that has been made in the knowledge of insects, the discovery of insecticides and of mechanical appliances for their application to field crops, as well as to orchards and gardens, I dare to assert that the insect does not exist, the injuries from which may not be materially lessened whenever its habits and life-history have become fully known.

The need of the study of these insect depredations, the importance of it, and the absolute necessity thereof, will be more evident when we consider, next

V. The Extent of the Study.

A comparative idea of the magnitude of the insect world, as contrasted with the entire animal kingdom, has already been given you. It may enable you to form a better idea of its extent, to state, that judging from the number of species now named and described — about 330,000 (we know and possess in our collections thousands of others awaiting study), and at the rate that new species have been added to our lists within the last half-century—it will not be an extravagant estimate, if for the present, we place the probable number of species existing in the world at one million. Although this figure is largely in excess of those made by other entomologists, I believe it to be a moderate one, in consideration of the limited study as yet given to some of the orders, and the still unexplored regions of the globe — entire continents in which scientific exploration has barely commenced. Its realization would but necessitate *less than the trebling* of the at present known species, with all future time available for the work; while during the years that have followed my boyhood, the number of described species has been *quintupled*.

From a scientific point of view, each species as discovered demands description that will give it positive recognition, and assignment to its proper place in classified lists. For economic purposes, but a small proportion will require the elaborate study that shall tell us all that we need to know of them. But what patience, what persistence, what an amount of study—extending it may be over several years—is often needed for the acquisition of a single life-history. Each of the four stages under

which insect life is presented to us—the egg, the larva, the pupa, and the imago, must receive its share of attention. The varied habits are to be observed and noted, under the complications frequently existing of change under changed conditions of food-plant, climate or locality.

The extent of the study will further appear from a consideration of the omnipresence of insects. As I have elsewhere written, "they abound in our homes, our gardens, orchards, fields, vineyards and forests. In the vegetable kingdom, they are found in the seed, the root, the stalk or trunk, the pith, the bark, the twig, the bud, the leaf, the blossom, and the fruit—within or upon every portion of the vegetable organism. They are parasitic on our persons and upon or within all of our domestic animals. They attack and destroy fishes and birds. They have their natural home in many articles of food. By their digusting presence and annoyance they may render our homes untenable. They burrow within our household and agricultural implements. They destroy our furniture and our clothing. They occasionally take possession of our books. No asylum is so secure that they may not intrude; no condition in life is exempt from their presence and attack."

VI. The Study has not been given its proper Share of Attention.

If you have followed me as I have attempted, in the brief time that I dare claim on this occasion, to show you the value of the Study of Entomology as a mental discipline—the facility with which it may be pursued—the interest attaching to it—its great practical importance—and the broad range that it embraces, you will, I think, agree with me, that it is very far from receiving the attention that it deserves and may justly claim. Notwithstanding the enormous losses annually sustained from insect depredations, how very few comparatively there are among us who can properly apply the familiar names of "bug," "beetle," or "butterfly." There are those whose crops are annually depleted, needlessly, to the amount of hundreds of dollars, who do not know that the caterpillar is but an immature stage of the winged moth or butterfly. This day, I find in a pretentious journal a notice of a destructive insect to this effect: "The insect appears first in the form of a small moth. In a few days, it sheds its wings and becomes a caterpillar, and a week thereafter it lays its eggs, each caterpillar producing two hundred."

In how many of our public schools and academies is Entomology given place? I do not know of one. In nearly all of our higher institutions and private schools, Botany is taught, and yet the former is certainly of far greater importance in the broad range of its economic applications. The State Normal College at Albany and the Oswego Normal School, have given excellent entomological instruction. Cornell University sus-

tains a Professorship in Entomology, with courses of lectures, laboratory work and Museum. Lectures in course upon it are given at Harvard University, the State College of Maine, the Massachusetts Agricultural College, the Michigan State Agricultural College, Purdue University at Lafayette, Ind., the Illinois Industrial University, the Iowa Agricultural College, the Kansas State Agricultural College, and the Leland Stanford Jr., University in California. In each of these State Institutions particular attention is paid to the economic aspect of the science.

The above, with the exception of some academic instruction in other States is the sum, so far as known to me, of what is being done in our institutions of learning in this department of Natural Science.

The reason for its almost entire neglect in our schools, is, undoubtedly the want of text books adapted to the young student. It might have rivaled Botany in popularity could its collections be named with the facility of plants. But for this we may never hope. The volumes that would be required for the simple identification by means of three- or four-lined diagnoses of the known United States species of insects, would be, at least, twenty of the size of Gray's School and Field Book of Botany—a series which would certainly prove inconvenient for general class use. A reference catalogue alone of the Diptera (flies) of North America, forms a volume three-fourths the size of the one above named; and a catalogue of the known Insects of the small State of New Jersey, giving name and occasionally brief annotations of locality and distribution, fills 486 pages octavo.

We should not wait for the desired text-books, such as will enable us to name our collections, for there is much else to learn of insects besides their names, as, for example, their structure, habits, transformations, and economic value. With "Packard's Guide to the Study of Insects" and "Comstocks Manual for the Study of Insects," in the possession of the student for reference, and with the insects before him upon his table, the teacher, having qualified himself for the work, may, in a series of lectures give to his class a better foundation for future study than could be acquired from books alone.

I lately had the privilege of attending one of the Lowell Institute Free Course of Lectures on Zoölogy, at Boston, given to the teachers of the Public Schools. Each of the about three hundred teachers in attendance had upon his or her table a box containing a half-dozen representative species in the order of Neuroptera, and a vessel of water in which were some macerated specimens with which to study structure. The lecture was further illustrated by diagrams and charts upon the wall. I was delighted with the lecture, and with the promise that it gave of the

good to result, when these trained teachers would form centres of similar instruction to other classes elsewhere.

In conclusion, if my plea for entomological study shall meet its desired response in inducing some of you to become faithful laborers in this broad field, where so large an amount of virgin soil is to be upturned, so much tillage is required, and such abundant fruit to be gathered — then, let me further ask of you, not to rest contented to gather for yourselves alone, but that from your superabundant stores you may make large contribution to others. Emulate the example of him whose honored and revered name your association bears. Ever find your greatest incentive to study, not in that it enriches yourself, but that you may impart to others. So gather from Nature's exhaustless stores and so distribute that your fellow-men shall be made the better, wiser and happier from your having been permitted to serve as Nature's interpreters.

More of honor than regal crown can bestow is in that single word, chiseled on a glacial block borne from beyond the seas to mark, so fittingly, the grave of Agassiz at Mount Auburn —TEACHER.

(C)

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST.

The following is a list of the principal publications of the Entomologist during the year 1896 — thirty-eight are named — giving title, place and time of publication, and a summary of contents.

On the Girdling of the Elm Twigs by the Larvæ of Orgyia leucostigma and its Results. (American Naturalist, xxx, January, 1896, pp. 74–75 — 17 cm.)

Its annual depredations in Albany; a new form of attack noticed in 1883, viz., girdling of the tips of the twigs; cause of the girdling; the girdling operations of a second brood of the Orgyia in August, 1895; a second brood not previously recorded in Albany; a feature shown in the twigs girdled by this brood; no similar girdling seen on any other of the Orgyia food-plants.

[Republished in pages 124–126 of the Eleventh Report.]

Wire-Worms in Corn. (Country Gentleman, for February 20, 1896, lxi, p. 144, c. 1—18 cm.)

Wire-worms reported as injuring corn seriously at Mullica Hill, N. J., the previous year. Buckwheat and mustard crops as preventives of wire-worms. Kainit possibly a remedy, although it gave unsatisfactory results at Cornell University. Baits of poisoned clover for the beetles recommended; midsummer plowing for destroying pupal cells and their occupants; rotation of crops; keeping fields in sod but a year or two at a time; thorough cultivation in autumn.

A Solution for Killing Worms. (Gardening, for March 15, 1896, iv, p. 199, c. 2—5 cm.)

Replying to an inquiry of a solution for killing worms, grubs, etc., in potted plants and on benches of greenhouses, several are named, as pyrethrum water (½ ounce to two gallons of water), quassia water, tobacco water, mustard water, and lime water. Vegetable solutions would be less liable to injure the roots of the plants.

The Apple Maggot, *Trypeta pomonella*. (Gardening, for April 1, 1896, iv, p. 218, cols. 2, 3 — 21 cm.)

The insect is stated to ruin annually in Western Massachusetts the fruit of several varieties of apples; inquiry is made of remedies. Reply is given that preventive measures must be mainly relied on. The parent insect flies from early July until frost, — the females

depositing their three to four hundred eggs singly beneath the skin on all parts of the apple. The eggs hatch in four or five days; mining habits of larvæ; they naturally pupate under ground. Destroying fallen fruit at once, using decoy trees for receiving the eggs, compacting the soil beneath trees or stirring it frequently, is recommended.

Apple Maggot. (Country Gentleman, for April 2, 1896, lxi, p. 270, c. 3 — 13 cm.)

It is reported as doing much damage to young apples in Fond du Lac county, Wisconsin; spraying is proposed. In reply, it is stated, that arsenites are of no value against this insect [*Trypeta pomonella*]; a good coating of the fruit with the Bordeaux mixture might prevent oviposition. General failure of the crop would probably reduce the numbers of the fly the following year, as it is sluggish and would hardly fly far. It can also breed in wild haws and crab apples. Best remedies: destruction of fallen fruit and using decoy trees. Arsenical spraying should not be neglected because of comparative exemption from insect attack.

The Cheese Skipper. (Country Gentleman, for April 9, 1896, lxi, p. 293, c. 2 — 28 cm.)

In response to inquiry, the meat-skipper is identified as the one found in cheese, viz., *Piophila casei* (Linn.). The perfect fly hibernates, appearing in warm weather in spring to oviposit; duration of stages. Long known only in cheese; in recent years infesting meat; losses caused in packing houses. Skippers reported from Moorefield, W. Va., on salted meat in January. Remedies: storing these products in darkness; excluding the flies. The work of the skippers does not produce ill odors or putresence.

[Extended in pp. 229–234 of this Report (xii).]

Scale Insects. (Gardening, for April 15, 1896, iv, p. 234, c. 1 — 14 cm.)

Scales on apple trees from Milwaukee, Mich., are identified as *Mytilaspis pomorum* and *Chionaspis furfurus*. Remedies are, cutting down when badly infested; for moderate attacks spray with kerosene emulsion reduced with nine parts of water when the young insects appear, or else from the middle to the end of May, for the latitude of Michigan.

The Southern Corn-Root Worm. (Country Gentleman, for April 30 1896, lxi, p. 353, cols. 2, 3 — 40 cm.)

"Bud-worms" which had nearly destroyed a field of corn in Fauquier Co., Va., are "the twelve-spotted Diabrotica," *D. 12-punctata* (Oliv.). The closely allied northern corn-root worm, *Diabrotica longicornis* (Say), is more destructive in the Northern States. Characters of the two species are given. The southern beetle is sometimes common North, and is a well-known pest of squashes, melons and cucumbers. The larvæ attack the corn just beneath the surface and cause wilting of the central leaf. Infested fields should not be replanted. No effective remedy is known.

Thousand-Legged Worms Infesting Greenhouses. (Gardening, for May 1, 1896, iv, pp. 251, 252, cols. 2, 3, 1—47 cm.)

Thousand-legged worms are reported as abounding in greenhouses at Kansas City, Mo., and not controlable by ordinary applications. From examples sent, the Myriapod is briefly described and identified as one of the flattened millepeds near to *Polydesmus complanatus* of Europe, which has not been recognized in this country. *Polydesmus Canadensis* is probably the species found to be so injurious by Dr. Fitch in this country. Many of the Myriapods feed only on decaying vegetable matter. Soot is said to drive them away. Kerosene or a strong kerosene emulsion will kill them; pyrethrum and hellebore might be tried. Baiting with chips, slices of carrots, etc., recommended Removal of the manure in the house in which they may have bred is advised.

[Extended in pp. 300–303 of this Report (xii).]

A Handbook of British Lepidoptera. By Edward Meyrick. (The Nation, lxii, May 14, 1896, p. 385, cols. 2, 3—33 cm.)

In a review of the above work, its comprehensiveness, completeness, and general excellence is commended. It contains descriptive text of 2061 species Analytical keys for the determination of the higher groups so complete have rarely if ever been given Its new system of classification is noticed, based on the author's study for years, of the Lepidoptera of the World. The system is so revolutionary as to be almost startling, but it is presented as a natural one, as based on resemblances resulting from traced community of descent. It is in accordance with the views advanced in Darwin's "Origin of Species," and has apparently been so carefully elaborated that in all probability it will have to be generally accepted by American Systematists. From the intimate relationship of the Lepidoptera of Great Britain and of the United States, the volume will be almost indispensable to American Students of Lepidopterology.

Elm-Leaf Beetle. (Country Gentleman, for May 14, 1896, lxi, p. 386, c. 3—6 cm.)

Examples sent with inquiry from Gaylordsville, Conn., taken on an attic window, are identified as *Galerucella xanthomelæna*, now *G. luteola*. They had doubtless just wakened from their winter's sleep in the attic and when found were seeking to escape to the elm for feeding and subsequent oviposition.

The Harlequin Cabbage Bug. (Gardening, for May 15, 1896, iv, p. 266, cols. 2, 3—26 cm.)

Insects destructive to cabbage and cauliflower in Tracy City, Tenn., are the harlequin cabbage bug, *Murgantia histrionica*. Its northward spread from Mexico is noticed, also its habits, and method of destroying it by drawing the early insects to mustard, cabbage stumps and sprouts for convenient killing, and by crushing the eggs.

A Plum Mite. (Country Gentleman, for May 21, 1896, lxi, p. 406, c. 2—16 cm.)

Leaves of a Chickasaw plum from Muncy, Pa., are deformed with galls showing on both surfaces of the leaf, produced by a gallmite which is seen under a powerful glass. Judging from the character of the gall, it is identical with that of *Phytoptus pruni* Amerl., which has not been previously detected in this country. For the destruction of the mite, hand-picking and burning the infested leaves early in the season, and winter spraying with kerosene emulsion are recommended.

[See page 318 of this Report (xii).]

The "Fire Worm." (Country Gentleman, for May 28, 1896, lxi, p. 431, cols. 3, 4—12 cm.)

The canker-worm, *Anisopteryx vernata* (Peck), is defoliating orchards in Amenia, N. Y., where it has previously been abundant. It is proving quite resistant to Paris green, and one pound of the green to 100 gallons of water has been required for killing it. Its habit of dropping from the foliage and being carried on its thread by the wind to other trees is noticed. It is known in Amenia, as the "fire worm," as the trees after the infestation, look as if they had been swept by fire.

[See pages 311–312 of this Report (xii).]

On the Girdling of Elm Twigs by the Larvæ of Orgyia leucostigma and its Results. (Proceedings of the American Association for the Advancement of Science — Forty-fourth meeting, held at Springfield, Mass., August–September, 1895. May, 1896, p. 156— 5 cm.)

A brief abstract of the paper under the above title was published in the American Naturalist for January, 1896. See page 347 of this Report.

Fruit Tree Aphides. (Country Gentleman, for June 11, 1896, lxi, p. 466, cols. 3, 4—12 cm.)

Some black aphides on cherry from East Hartford, N. Y., are identified as the cherry-tree aphis, *Myzus cerasi* (Fabr.), and the green ones on plum as *Aphis prunifolia* Fitch. The former is a common and widely distributed pest, while the latter is much less so. Spraying the plant-lice with whale-oil soap solution or strong tobacco water on their first appearance is effective. After the leaves curl, the spray is not effective. The Syrphid larvæ found preying on the aphides would probably soon destroy them all.

[Kill the Larvæ of the Elm-leaf Beetle.] (Albany Evening Journal, for June 24, 1896, p. 4, c. 4—16 cm.)

The larvæ of the first brood are now descending for pupation, and by killing them with hot water or kerosene, the ravages of the second brood may be largely prevented. This method is simple, while general spraying is impracticable. Infested trees—confined almost entirely to European elms, are indicated by small spots on sidewalks ordinarily

left by the larvæ trodden under foot. The American elm in Albany is so far exempt from attack.

[Extended in pages 253-264 of this Report (xii).]

[Report on the Work of the Gypsy Moth Committee after an Examination made in June, 1893.] (The Gypsy Moth, *Porthetria dispar* (Linn.)—A Report of the Work by E. H. Forbush & C. H. Fernald [June], 1896, Appendix D, pp. xxxii–xxxv).

The pages cited contain (in part) a report made by the N. Y. State Entomologist, following an examination, at the request of the Committee, of their operations. As the result of the examination of the field and office work, and at the Insectary, nothing was found to criticise. Liberal appropriations by the State Legislature and a continuance of the work of the Committee were recommended. Two suggestions were offered, viz.; that the entire service of the Entomologist, Prof. Fernald, be secured, if possible, and that the cultivation of parasites be entered upon and vigorously prosecuted, somewhat on the plan of which an outline is given. Possibly by this means only, can extermination of the moth be effected.

The Elm-tree Beetle in Albany, (Albany Express, for July 1, 1896.)

Gives the progress of the insect up the valley of the Hudson river since its appearance at Newburg, N. Y., in 1879, until its invasion of Albany in 1892; also, its slow spread in Albany and best methods for its destruction.

Rose Bugs. (Gardening, for July 1, 1896, iv, p. 311, c. 2—11 cm.)

A correspondent, Mrs. Chrisman, states that rose-bugs may usually be traced to a hatching ground, where they could be killed by the application of a few sacks of salt. The editor requests comment on the above. It is given to the effect that the correspondent has undoubtedly been successful in tracing the rose-bugs in her neighborhood to a common hatching ground in a swamp, and draining the locality is suggested as a remedy for the continued breeding. Salt, as suggested, may prove effectual, and it would be well to experiment with it.

Tenth Report on the Injurious and Other Insects of the State of New York for the Year 1894. Albany, 1895. [Issued July 8, 1896.] Pages 297, plates 4, figures 24. (Forty-eighth Report on the New York State Museum, for the year 1894. Albany, 1895, pp. 297, plates 4, figs. 24.)

The contents are: TRANSMITTAL. INJURIOUS INSECTS, etc.: Ants on Fruit-Trees. Derostenus sp? Operations against the Gypsy-Moth in Massachusetts. Gortyna immanis, the Hop Vine Grub. Gortyna cataphracta, as a Raspberry-cane borer. Collections in the Adirondack Mountains in 1893. Sitotroga cerealella, the Grain-Moth. Diplosis pyrivora, the Pear-Midge. Notes on Sciara. Sciara coprophila, the Manure-Fly. Sciara caldaria, the Greenhouse Sciara. Phora agarici,

the Mushroom Phora. Agrilus ruficollis, the Gouty-Gall Beetle. Anomala lucicola, the Light-loving Grapevine Beetle. Anomala marginata, the Margined Anomala. Diabrotica vittata, the Striped Cucumber Beetle. Dibolia borealis, a Plantain-Leaf Miner. Otiorhynchus ovatus, the Ovate Snout-Beetle. Conotrachelus cratægi, the Quince Curculio. The Seventeen-Year Locust in the State of New York in 1894. Psylla pyricola, the Pear-Tree Psylla. Remarkable abundance of Aphides or Plant-Lice in 1893. Are Aphides Eaten by Spiders? Pentatoma juniperina, the Juniper Plant-Bug. Leptocoris trivittatus, the Box-elder Plant-Bug. The Grasshopper Plague in Western New York. Julus cæruleocinctus, with Associated Potato-Scab. Mites Attacking Mushrooms. Mites Infesting Potatoes. Tyroglyphus Lintneri, a Mushroom-Infesting Mite. Phytoptus pyri, the Pear-Leaf Blister-Mite. APPENDIX. (A) THE SCORPION-FLIES; PANORPA RUFESCENS; BITTACUS STRIGOSUS. (B) LIST OF DATES OF COLLECTIONS OF LEPIDOPTERA (HETEROCERA). (C) LIST OF PUBLICATIONS OF THE ENTOMOLOGIST. (D) ENTOMOLOGICAL PUBLICATIONS OF J. A. LINTNER, 1862–1869. (E) CONTRIBUTIONS TO THE DEPARTMENT IN 1893. (F) CONTRIBUTIONS TO THE DEPARTMENT IN 1894. (G) CLASSIFIED LIST OF INSECTS NOTICED IN REPORTS I–X. (H) ERRATA (ADDITIONAL) IN PRECEDING REPORTS. INDEX TO REPORTS I–X.

The Army Worm Invasion. (The Argus [Albany, N. Y.], for July 8, 1896, p. 8, c. 3—28 cm.; the same, in part, in New York Recorder, for July 15, 1896—18 cm.; Country Gentleman, for July 16, 1896, lxi, p. 552, c. 1—24 cm.; Rome Sentinel, for July 17, 1896—12 cm.; Circular of the Department of Agriculture of the State of New York.)

The army-worm appears in Washington County, N. Y., the first week in July, and in other localities near Albany, in immense numbers and quite injurious. Crushing them and ditching to arrest their progress is recommended, also spraying narrow strips in advance of their march with Paris green. Its injuries will soon cease. None of its parasites seen as yet.

[Extended in pages 190–214 of this Report (xii).]

Wire Worm. (Country Gentleman, for July 9, 1896, lxi, p. 540, cols. 1, 2–13 cm.)

Examples sent from Hackettstown, N. J., where they have been quite injurious to corn, are identified as wire-worms and their general characters given. No entirely effective remedy for them has been found. Kainit is said to be a remedy. Salt is of doubtful value. Plowing in the autumn and attracting to baits recommended.

The Army Worm Invasion. (New York Daily Tribune, for Saturday, July 18, 1896—57 cm.)

The presence of the army worm [*Leucania unipuncta*] in eastern New York. The caterpillars unusually abundant and destructive. Lime, plaster, rolling the ground, ditching, etc., recommended. No

parasites observed. Favoring meteorological conditions responsible for their immense numbers. Not likely to be so numerous another year.

[Extended in pages 190–214 of this Report (xii).]

Tent Caterpillar. (Country Gentleman, for July 23, 1896, lxi, p. 571, c. 4—5 cm.)

An example of a moth occurring in great numbers sent for identification from Baltimore, Md., was the apple-tree tent-caterpillar [*Clisiocampa Americana*]. Some particulars relating to the cocoon and the moth were given in reply.

The Army Worm. (Country Gentleman, for July 23, 1896, lxi, p. 574, cols. 3, 4—32 cm.)

The caterpillars were reported in the last week of June. The week following, many had nearly attained their growth and were destroying grains and grasses in most of the southeastern counties of the State. Ditching, rolling, spraying infested strips with Paris green, and applications of air-slacked lime, plaster, or even road dust, recommended. The most serious injury has already been committed. The moth, *Leucania unipuncta*, is not uncommon. The unusual abundance of the insect this year is due to meteorological conditions which may not prevail the coming year.

[Extended in pages 190–214 of this Report (xii).]

Cut-Worms and Borers. (Country Gentleman, for July 30, 1896, lxi, p. 591, cols. 1, 2—22 cm.)

In response to inquiry from Montclair, N. J., for remedies for cut-worms and borers it is stated that the feeding and other habits of cut-worms are so various that no one general remedy can be given. Fresh clover sprinkled with Paris green water and laid in loose bunches between the rows, or cabbage or turnip leaves treated in a similar manner, have been found quite effective. Bran mash poisoned with arsenic might be used in the same manner. Digging out the cut-worms is sure and not very laborious. The soft-soap carbolic acid wash poisoned with Paris green is recommended for borers. Common whitewash is believed to be a preventive by many.

More About the Army Worm. (Country Gentleman, for August 6, 1896, lxi, p, 606, cols. 1, 2 — 52 cm.)

The army worm [*Leucania unipuncta*], reported as injurious on many farms at Orchard Home, N. Y. Ditching was quite effective and it was found that plowing a furrow and returning in it, gave good results. Holes, 10 or 15 inches deep at intervals in the furrows, proved efficient. The wheat bran mash reported effective, the worms descending from the corn to eat it.

In reply, the precautions taken are commended, though deeper holes are preferable. The dead worms observed on the ground may have been killed by ground beetles, *Carabidæ*, or by parasitic flies

Nemoræa leucaniæ [*Winthemia 4-pustulata*]. When and where the eggs are laid and other items of life-history.

[Extended in pages 190–214 of this Report (xii).]

Snapping Bugs. (Country Gentleman, for August 6, 1896, lxi, p. 610, c. 1 — 12 cm.)

In response to an inquiry from Beaver Creek, Col., it is stated, that it has been found serviceable to attract click-beetles, or snapping-bugs to poisoned baits, from May to August inclusive. The exact time for continuance of the baits to be ascertained by the number of beetles drawn to them. Freshly cut clover, dipped in Paris green water, is perhaps, the best bait. A corn or bran mash sweetened with sugar and containing arsenic should be effective.

Blister Beetles. (Country Gentleman, for August 13, 1896, lxi, p. 624, c. 3 — 12 cm.)

Insects sent from Madison, N. J., where they had been feeding on beets and mangels, are of two species. The black one, with a narrow ash colored margin on the wing covers, is the "margined blister beetle," *Epicauta cinerea* (Forst.), a common and destructive species at times, feeding on potato and tomato leaves; seldom continuing longer than a week. The other, "the striped blister-beetle," *Epicauta vittata* (Fabr.), is especially destructive to potatoes and is a more southern form. Lime or plaster of Paris are remedies. The larvæ of these beetles, destroy grasshopper eggs and are therefore beneficial.

Willow Butterfly. (Country Gentleman, for August 27, 1896, lxi, p. 666, cols. 1, 2 — 10 cm.)

Caterpillars, identified as *Vanessa Antiopa*, are stated to have ravaged trees on the bar [at Whitehall, N. Y.], next the Lake, to an extent that caused them to look as if dead. Their occurrence in such destructive numbers is quite unusual.

Caterpillars and Parasites. (Country Gentleman, for August 27, 1896, lxi, p. 670, cols. 1, 2 — 21 cm.)

A half-grown larva of *Ampelophaga Myron* (Cramer), from a woodbine at Port Kent, N. Y., is nearly covered with the cocoons of its common parasite, *Apanteles congregatus*. The history of the parasite is given, and also of a secondary parasitic attack by a Chalcid on Apanteles.

The Oak Pruner. (Country Gentleman, for September 3, 1896, lxi, p. 682, c. 4 — 6 cm.)

The small limbs of some hard maple trees at Baltimore, Md., are cut off by some insect, as clean, as though with a knife. The attack is identified, as, in all probability, that of the oak pruner, *Elaphidion parallelum* Newm. The insect may be kept in check by collecting the fallen branches and burning them.

The Beech-Tree Blight. (Country Gentleman, for September 10, 1896 lxi, p. 705, c. 4 — 26 cm.)

Beech leaves from Scarsdale, N. Y., are thickly infested with *Schizoneura imbricator* (Fitch). The enveloping white substance is noticed, and the honey dew which it secretes. As the insect is difficult to reach with insecticides, crushing the collected masses is recommended.

Elm-Tree Borer. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 1 — 14 cm.)

A borer, infesting elm-trees in Peoria, Ill., is identified from the account given of it, as the elm-tree borer, *Saperda tridentata* Olivier. The best remedies for it are these: 1. Removing the dead bark over the infested portion until the insects are reached, and applying kerosene emulsion to kill them. 2. Preventing egg-laying by coating the portion of the trunk threatened with a repellant coating in which Paris green and carbolic acid are mixed.

[Extended in pp. 243-248 of this Report (xii).]

The Cecropia Moth. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 2 —9 cm.)

A supposed vegetable growth on a grapevine, from Auburn, N. Y., is the cocoon of *Attacus Cecropia*. Features of the cocoon are given from which it may be recognized.

Imported Scale Insects. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 3 — 13 cm.)

In commenting on a statement of the recent arrival at Seattle, Wash., of a steamship from Japan, with some Japanese plants badly infested with a destructive scale-insect, the importance is urged of such quarantine regulations at that port as shall prevent the introduction of the scale insects of Japan, and also at other of our ports where plants and fruits are largely imported. The particular scale referred to above, *Diaspis lanatus*, has been in the United States for at least four years, having probably been introduced from the West Indian Islands, and is now in Florida, Georgia, and District of Columbia on peach trees. How destructive it may prove, remains to be seen.

Pea Bugs. (Country Gentleman, for October 1, 1896. lxi, p. 763, cols. 3, 4—12 cm.)

In reply to inquiry from Baiting Hollow, L. I., the life-history of the pea-weevil, *Bruchus pisorum* is given, and for killing the insect, chloroform or bisulphide of carbon are recommended.

Rose-Leaf Hopper. (Country Gentleman, for October 1, 1896, lxi, p. 763, c. 4—10 cm.)

A remedy is asked for from Port Kent, N. Y., for "a small white fly infesting rose-bushes." It is probably "the rose-leaf hopper," *Typhlo-*

cyba rosæ (Harris), and for destroying it, the following are recommended: whale-oil soap, tobacco water (made after formula given), pyrethrum powder mixed with flour, and a strong stream from a garden hose of cold water. The last, if used on the young larvæ, is a simple and effective remedy.

The Wheat Wire Worm. (Country Gentleman, for October 22, 1896, lxi, p. 826, c. 1—21 cm.)

Agriotes mancus (Say) was received from Torresdale, Pa., as having ruined potato crops. Features of wire-worms; the difficulty in dealing with them, and their life-period. Kainit or other potash salts are recommended for their destruction, also baits of poisoned clover for the beetles, and late plowing for crushing the pupæ.

Apple-Tree Borers. (Country Gentleman, for December 10, 1896, lxi, p. 949, cols. 2, 3—36 cm.)

The borers that are infesting old trees which always drop their fruit before ripening, in Pittsburg, Pa., are probably the round-headed and flat-headed borers, *Saperda candida* Fabr. and *Chrysobothris femorata* (Fabr.). The trees may possibly be saved by proper fertilizers and prevention of further attack. A soft soap and carbolic acid wash applied the last of May and renewed whenever needed, is a good preventive of egg deposit. The "Saunders Wash" of soft soap and washing soda, is highly esteemed in Canada. "Dendrolene" may not as yet be recommended for general use. Remedies, are cutting out or crushing the borers after the methods stated. For protection of young trees wrap bands of cloth or folds of newspaper around the base of the trees for a foot or more.

Notes on Some of the Insects of the Year in the State of New York. (Bulletin 6, New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896 pp. 54–61.)

The year has been characterized by the unusual harmlessness of a number of common insect pests, and the remarkable scarcity of insect life with a few exceptions. Notes on the following insects are given: *Leucania unipuncta*, *Leucania albilinea*, *Anisopteryx vernata*, *Cacœcia rosaceana*, *Nolophana malana*, Cecidomyiid larva on choke-cherry, *Euphoria Inda*, *Elaphidion villosum*, *Crioceris asparagi*, *Macrobasis unicolor*, Chinch-bug, *Aspidiotus perniciosus*, *Kermes galliformis*, and *Gossyparia ulmi*.

[See pages 307-318 of this Report (xii).]

Eleventh Report on the Injurious and Other Insects of the State of New York for the Year 1895. Albany, 1896. [Issued January 21, 1897.] Pages 238, plates 16, figures 25. (Forty-ninth Report on the New York State Museum, for the Year 1895. Albany, 1897 [issued in October, 1897], pp. 245, plates 16, figures 25.)

The contents are: INTRODUCTORY. INJURIOUS INSECTS: Monomorium Pharaonis, the Little Red Ant. Ants in a Lawn. On

Arsenical Spraying of Fruit Trees while in Blossom. On the Girdling of Elm Twigs by Orgyia leucostigma. Eudioptis nitidalis, the Pickle Caterpillar. Eudioptis hyalinata, the Melon Caterpillar. Pyrausta futilalis, a Dogbane Caterpillar. Mecyna reversalis, the Genista Caterpillar. Pyralis costalis, the Clover-Hay Caterpillar. Grapholitha interstinctana, the Clover-seed Caterpillar. Antispila nyssæfoliella, the Sour Gum-tree Case-Cutter. Tischeria malifoliella, the Apple Leaf Miner. Cecidomyia betulæ, the Birch-tree Midge. Diplosis cucumeris, the Melon-vine Midge. Diplosis setigera, the Hairy Melon-vine Midge. Anthomyia sp., ? the Raspberry-cane Maggot. Anthrenus scrophulariæ, the Carpet-Beetle. Pyrophorus noctilucus, the Cucuyo. Crioceris asparagi, the Asparagus Beetle. Lina scripta, the Cottonwood-leaf Beetle. Galerucella luteola, the Elm-leaf Beetle in Albany. Galerucella cavicollis, a Cherry-leaf Beetle. Blissus leucopterus, the Chinch-bug. The San José Scale [Aspidiotus perniciosus], and Other Destructive Scale Insects of New York. Myrmeleon sp. ?, the Ant Lion. Thrips tabaci, the Onion Thrips. Schoturus nivicola, the Snow Flea. Achorutes diversiceps. Tyroglyphus heteromorphus, a Carnation Mite. APPENDIX. (A) LIST OF INJURIOUS APPLE-TREE INSECTS. (B) LIST OF PUBLICATIONS OF THE ENTOMOLOGIST. (C) CONTRIBUTIONS TO THE DEPARTMENT IN 1895. (D) CLASSIFIED LIST OF INSECTS, ETC., NOTICED IN THIS REPORT. (E) EXPLANATIONS OF PLATES. INDEX.

(D)

CONTRIBUTIONS TO THE DEPARTMENT IN 1896.

Hymenoptera.

Saw-fly larvæ, *Hylotoma pectoralis* Leach, feeding on birch, August 12th. From Mrs. H. D. Graves, Ausable Forks, N. Y.

Larvæ of the pear-tree slug, *Eriocampa cerasi* (Peck), August 18th. From R. W. Strickland, Albion, N. Y.

Larvæ of the willow apple gall saw-fly, *Pontania pomum* (Walsh), from Delmar, N. Y., August 19th. From Prof. C. H. Peck, Menands, N. Y.

Tenthredo rufopectus (Norton), imago, May 25th from currant twig. From Thomas Tupper, Corning, N. Y.

The lunated long-sting, *Thalessa lunator* (Fabr.), June 4th. From Frank Unger, Albany, N. Y.

Bracon sp. From Mrs. E. C. Anthony, Gouverneur, N. Y.

A Chalcid, *Brucophagus* sp., from the fungus *Peridermium cerebrum* on *Pinus tæda* from Auburn, Ala. From Prof. C. H. Peck, Menands, N. Y.

The large digger-wasp, *Sphecius speciosus* (Drury), from a lawn, August 16th. From James Reynolds, Poughkeepsie, N. Y.

A leaf-cutter bee, *Megachile montivaga* Cress.; *Peiopœus cœmentarius* (Drury), *Chalybion cæruleum* (Drury), and *Tripoxylon politum* Say. From Mrs E. B. Smith, Coeymans, N. Y.

Lepidoptera.

Larvæ of *Vanessa Antiopa* (Linn.), devastating willows, June 11th. From C. T. Hawley, Jr., Cambridge, N. Y.

Larva of *Thyreus Abbotii* Swainson, July 7th; larva of *Deilephila chamænerii* Harris, var., from *Œnothera biennis*, October 20th. From Mrs E. B. Smith, Coeymans, N. Y.

Larva of *Ampelophaga Myron* (Cramer), parasitized by *Apanteles congregatus*, and these, in turn, by a Chalcid, August 16th. From Mrs. D. D. Kellog, Port Keat, N. Y. The same, in the same double parasitism, August 22d, from Mrs. E. C. Anthony, Gouverneur, N. Y.

Larva of *Ceratomia Amyntor* (Hübn.), August 21st. From F. J. Riggs, Albany, N. Y.

Hypoprepia fucosa Hübn., August 8th. From Mrs. K. E. TURNBULL, Tannersville, N. Y.

Larvæ (10) of *Empretia stimulea* Clemens, August 7th, on a leaf of garden cherry. From Dr. S. A. RUSSELL, Poughkeepsie, N. Y. The same, 7 examples on cherry, August 31st, from J. F. ROBINSON, Middletown, N. Y.

Egg-belt of *Clisiocampa Americana* Harris, June 17th, of the present year. From J. S. WHITCOMB, West Somerset, N. Y.

The leopard moth, *Zeuzera pyrina* (Fabr.), June 5th. From A. H. STRATTON, Arlington, N. J.

Eacles imperialis (Drury). From Mrs. E. C. ANTHONY, Gouverneur, N. Y.

Harrisimemna trisignata Walker, and *Agrotis subgothica* Haworth, Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

The army-worm, *Leucania unipuncta* (Haworth), July 1st, from J. N. MCHARG, Albany, N. Y. The same, July 2d, from S. E. SPALDING, Cambridge, N. Y. The same, July 6th, taken at Wemple, N. Y., from Hon. J. S. BAILEY, Albany, N. Y. The same, September 25th and October 2d, from H. S. AMBLER, Chatham, N. Y.

Xylina Bethunei Gr.-Rob., Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

Young apples eaten into by the larvæ of *Cacœcia rosaceana* (Harris), with examples of the larvæ, May 27th. From W. A. LAFLER, Albion, N. Y.

Examples of the currant span-worm, *Eufitchia ribearia* (Fitch), feeding destructively on gooseberries, June 5th. From LYMAN H. HOYSRADT, Pine Plains, N. Y.

The spring canker-worm, *Anisopteryx vernata* (Peck), May 21st. From E. J. PRESTON, Amenia, N. Y.

Ephestia interpunctella Zeller, the larvæ in samp, split peas, "wheat germ meal and wheatlet," September 4th. From MELVIL DEWEY, Albany, N. Y.

Pears infested with the apple-worm, *Carpocapsa pomonella* (Linn.). From Prof. C. H. PECK, Albany, N. Y.

The apple tree case-bearer *Coleophora Fletcherella* Fernald; the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, in the pupal stage on apple twigs, September 15th. From W. A. THACKER, Walcott, Wayne county, N. Y.

Larvæ of the willow-apple Tineid, *Batrachedra salicipomonella* Clemens, feeding within the galls of *Pontania pomum* (Walsh), August 19th, at Delmar, N. Y. From Prof. C. H. PECK, Albany, N. Y.

DIPTERA.

The dog-flea, *Pulex serraticeps* Gerv. From EARL S. CRANNEL, Albany, N. Y.

Larvæ of *Cecidomyia* sp. in galled choke-cherries, May 28th, from Bethleham, N. Y. From Prof. C. H. PECK, Menands, N. Y.

The pear-midge, *Diplosis pyrivora* Riley. From Dr. J. B. SMITH, New Brunswick, N. J.

Examples of *Sciara multiseta* Felt reared from mushrooms, *S. pauciseta* Felt from potatoes, and *S. fulvicauda* Felt from decaying blackberry roots; and of *Phora abidihalteris* Felt from mushrooms. From Dr. J. B. SMITH, New Brunswick, N. J.

Chrysops sp. near *nigra*, *Scenopinus fenestralis* (Linn.), and *Pollenia rudis* (Fabr.). From Mrs. E. B. SMITH, Coeymans, N. Y.

Larvæ of *Anthomyia* sp., mining beet leaves, June 16th. From C. W. SEELYE, Rochester, N. Y.

Larvæ and pupa of *Meromyza Americana* Fitch, from stalks of wheat, quite destructive in Altdorf, Wisc., June 24th. From E. S. GOFF, Madison, Wisc.

Larvæ of a Phorid (?), infesting, in association with coleopterous larvæ, the fungus, *Clitocybe illudens*, October 1st; also, numerous dipterous larvæ and imagoes from mushrooms, Sept. 29th. From C. H. PECK, Menands, N. Y.

COLEOPTERA.

Calosoma scrutator (Fabr.), September 4th. From G. R. HOWELL, Albany, N. Y.

Calosoma calidum (Fabr.), *Silpha Surinamensis* (Fabr.), *Chalcophora Virginiensis* (Drury), *Dicerca divaricata* Say, *Aphodius* sp., *Osmoderma scabra* (Beauv.), *Monohammus confusor* (Kirby). From Mrs. E. C. ANTHONY, Gouverneur, N. Y.

Coccinella 9-notata Hübn., *Alaus oculatus* (Linn.), *Epicauta cinerea* (Forst.) From Mrs. E. B. SMITH, Coeymans, N. Y.

The twice-stabbed lady-bird, *Chilocorus bivulnerus* Muls., from mountain ash, June 1st. From A. H. STRATTON, Arlington, N. J.

Silvanus Surinamensis (Linn.), in wheat flour, August 22d. From F. J. RIGGS, Albany, N. Y. The same in samp, split-peas, flour, raisins, and dried currants, from MELVIL DEWEY, Albany, N. Y. The same in "Cerealine," from F. J. RIGGS, Albany, N. Y.

Wireworms, *Elateridæ*, from roots of corn. From C. W. SARGENT, Hackettstown, N. J.

The Pennsylvania soldier beetle, *Chauliognathus Pennsylvanicus* (DeGeer), Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

Tenebrioides Mauritanica (Linn), from Miss M. SEYMOUR, Albany, N.Y.

Living examples of the cucuyo *Pyrophorus noctilucus* (Linn), June 17th. from the Island of San Domingo, W. I. From Mrs. EDMUND H. SMITH, Albany, N. Y.

Amphicerus bicaudatus (Say), taken while boring into a species of "African tamarisk," May 25th. From V. H. LOWE, N. Y. Agricultural Experiment Station, Geneva, N. Y.

Lucanus dama Thûnb., June 10th. From R. H. SHREVE, Albany, N. Y.

The rose-bug, *Macrodactylus subspinosus* (Fabr.), June 10th, on apple. From Mrs. M. B. WELCH, South Butler, N. Y.

Pelidnota punctata (Linn.). From F. J. RIGGS, Albany, N. Y.

Larvæ (10) of *Euphoria Inda* (Linn.), from chip manure. From Prof. C. H. PECK, Albany, N. Y. The same, imago, injuring pears September 9th. From JAMES HENDRICKS, Albany, N. Y.

Elaphidion parallelum Newm., June 2d, in apple branches. From J. A. HOUCK, Albany, N. Y. Pruned twigs of the same, of Norway maple (many) and of pig-nut hickory (one), August 23d. From GEORGE T. LYMAN, Bellport, Suffolk Co., N. Y.

The maple-tree borer, *Plagionotus speciosus* (Say), June 29th. From A. P. WILLIAMS, Mannsville, Jefferson Co., N. Y.

Crioceris asparagi (Linn.), in eggs, larvæ, and imagoes, June 2d. From A. P. CASE, Vernon, Oneida Co., N. Y.

Chlamys plicata (Fabr.), in eggs and larvæ, on hickory, May 23d. From W. R. WALTON, Middletown, N. Y.

Bruchus obtectus Say, February 14th. From G. M. PATIEN, Poughkeepsie, N. Y.

The ash-gray blister-beetle, *Macrobasis unicolor* (Kirby), June 19th, feeding on the honey locust. From M. T. Richardson, New York City. The same, from potatoes, June 25th, from ——— ———, Factoryville, N. Y.

Tribolium confusum Duval and *Calandra granaria* (Linn.), August 18th, infesting graham flour. From F. J. RIGGS, Albany, N. Y.

Scolytus rugulosus Ratz. (7 examples), August 13th, boring into apple and peach trees. From Prof. C. H. PECK, Albany, N. Y.

HEMIPTERA.

The harlequin cabbage bug, *Murgantia histrionica* (Hahn.). from cauliflower, April 23d. From E. A. NATHURST, Tracy City, Tenn.

Lygus pratensis (Linn.), from potatoes, June 22d. From D. F. HARRIS, Adams, N. Y.

The four-lined leaf-bug, *Pœcilocapsus lineatus* (Fabr.). From Miss L. F. CLARKE, Canandaigua, N. Y.

The dog-day Cicada, *Cicada tibicen* Linn., July 31st and August 18th. From F. J. RIGGS, Albany, N. Y.

Typhlocyba vitis (Harris), from grape, September 4th. From Prof. C. H. PECK, Albany, N. Y.

Pemphigus imbricator (Fitch), on beach, August 31st. From D. J. GARTH, Scarsdale, N. Y.

Gossyparia ulmi Geoff., June 4th. From J. B. WASHBURN, Albany Co., N. Y.

Kermes galliformis Riley, from scrub oak, containing in December, pupæ of *Enclemensia Bassettella* (Clemens). From W. R. WALTON, Middletown, N. Y.

Lecanium sp., thickly encrusting a maple twig, May 13th. From SELWYN A. RUSSELL, M. D., Poughkeepsie, N. Y.

Lecanium sp. on *Prunus Simoni*, May 26th. From LEWYLLEN DEFREEST, DeFreestville, Rensselaer Co., N. Y.

The San José scale, *Aspidiotus perniciosus* Comst. on pear, from T. C. ROYCE, Middletown, N. Y. The same, Nov. 28th, on apple, from Dr. EDWARD MOORE, Loudonville, N. Y.

ORTHOPTERA.

The mole cricket, *Gryllotalpa borealis* (Burm.), Sept. 28th. From J. W. BAYER, Saratoga Springs, N. Y.

Ceuthophilus maculatus (Harris), *Cyrtophyllus concavus* (Harris), *Amblycorypha oblongifolia* (De Geer), and *Diapheromera femorata* (Say). From Mrs. E. B. SMITH, Coeymans, N. Y.

Chortophaga viridifasciata (De Geer). From Mrs. E. C. ANTHONY, Gouverneur, N. Y.

Periplaneta Australasiæ (Fabr.). From ERNEST F. IRVIN, Sinclairville, N. Y.

Periplaneta orientalis (Linn.). From SILAS W. BURT, New York City.

NEUROPTERA.

Epicæschna heros (Fabr.), June 9th. From Mr. KING, Fort Edward, N. Y.

Gomphus adelphus Selys, Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

Numerous examples of a Psocid occurring in oat refuse, September 29th. From H. S. AMBLER, Chatham, N. Y.

MYRIAPODA.

? *Polydesmus falcatus* Lintn. infesting greenhouses, February 12th. From J. G. CAMPBELL, Kansas City, Mo.

Cermatia forceps Raf., June 10th, in the Capitol. From L. M. LEE, Albany, N. Y.

(E)

CLASSIFIED LIST OF INSECTS, ETC., NOTICED IN THIS REPORT.

HYMENOPTERA.

Tenthredo rufopectus (*Norton*), the red-breasted Tenthredo.
Tremex columba (*Linn.*), the pigeon Tremex.
Ophion purgatum *Say*, the purged Ophion.
Thalessa lunator (*Fabr.*), the lunate long-sting.
Apanteles militaris (*Walsh*), the military Apanteles.
Camponotus herculaneus (*Linn.*), a large black ant.
Formica exsectoides *Forel*, an eastern mound-building red ant.
Formica obscuripes *Forel*, a western mound-building red ant.
Formica rufa *Linn.*, the European wood-ant.
Formica subsericea *Say*, the large black ant.

LEPIDOPTERA.

Ecpantheria scribonia (*Stoll*), the great white leopard-moth.
Datana integerrima *Gr.-Rob.*
Attacus Promethea (*Linn.*), the Promethea moth.
Leucania albilinea (*Hubn.*), the wheat-head army-worm.
Leucania unipuncta (*Haworth*), the army-worm.
Eufitchia ribearia (*Fitch*), the gooseberry span-worm.
Anisopteryx vernata (*Peck*), the spring canker-worm.
Oxyptilus periscelidactylus (*Fitch*), the gartered plume-moth.
Cacœcia rosaceana (*Harris*), the oblique-banded leaf-roller.
Proteoteras æsculana (*Riley*), a maple and buckeye twig-borer.
Steganoptycha Claypoliana (*Riley*), a new maple-tree insect.
Euclemensia Bassettella (*Clemens*), a parasite of Kermes.

DIPTERA.

Cecidomyia species in choke cherries.
Sciara fulvicauda *Felt.*
Sciara agraria *Felt.*

Sciara multiseta *Felt.*
Sciara pauciseta *Felt.*
Sciara prolifica *Felt.*
Culex species, mosquitoes.
Winthemia 4-pustulata (*Fabr.*), the red-tailed Tachina-fly.
Belvoisia unifasciata *Desv.*, the yellow-tailed Tachina-fly.
Piophila casei (*Linn.*), the cheese skipper: the ham skipper.
Phora albidihalteris *Felt.*

COLEOPTERA.

Calosoma calidum (*Fabr.*), the fiery ground-beetle.
Lebia grandis (*Hentz*), an enemy of the Colorado potato-beetle.
Euphoria Inda (*Linn.*), the Indian Cetonian.
Elaphidion villosum (*Fabr.*), the oak pruner.
Elaphidion parallelum *Newm.*, the maple-tree pruner.
Plagionotus speciosus (*Say*), the sugar maple borer.
Neoclytus erythrocephalus (*Fabr.*), an elm, hickory and locust borer.
Saperda tridentata *Olivier*, the elm borer.
Crioceris asparagi (*Linn.*), the asparagus beetle.
Crioceris 12-punctata (*Linn.*), the twelve-spotted asparagus beetle.
Galerucella luteola (*Müller*), the elm-leaf beetle.
Odontota dorsalis *Thunb.*, a locust leaf-miner.
Macrobasis unicolor (*Kirby*), the ash-gray blister beetle.
Balaninus rectus *Say*, the smaller chestnut-weevil.
Balaninus proboscideus (*Fabr.*), the larger chestnut-weevil.

HEMIPTERA.

Podisus spinosus (*Dallas*), the spined Podisus.
Metapodius femoratus (*Fabr.*), the thick-thighed Metapodius.
Blissus leucopterus (*Say*), the chinch-bug.
Cicada septendecim *Linn.*, the periodical Cicada.
Pemphigus rhois (*Fitch*), the sumac-gall aphis.
Gossyparia ulmi (*Geoff.*), the elm-tree bark-louse.
Kermes galliformis *Riley*, the oak Kermes.
Aspidiotus perniciosus *Comst.*, the San José scale.

NEUROPTERA.

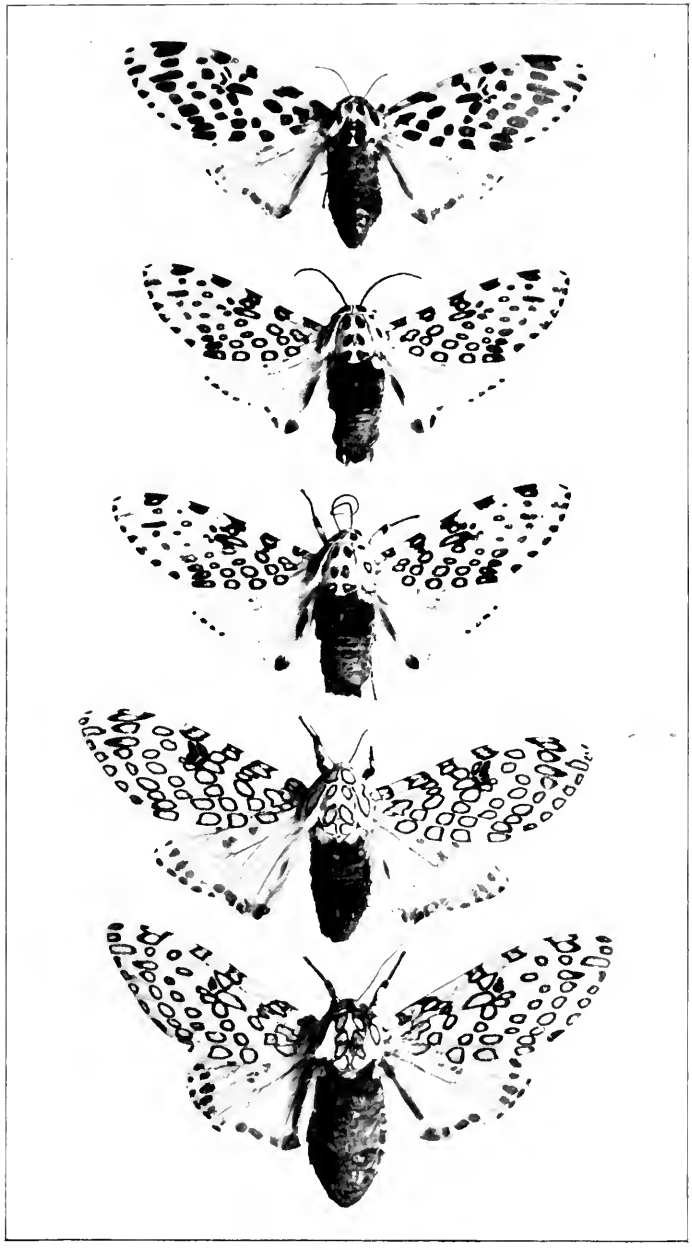
Neuronia pardalis *Walker*, the spotted Neuronia.

ARACHNIDA.

Phytoptus pruni *Amerl.*, a Chickasaw plum mite.

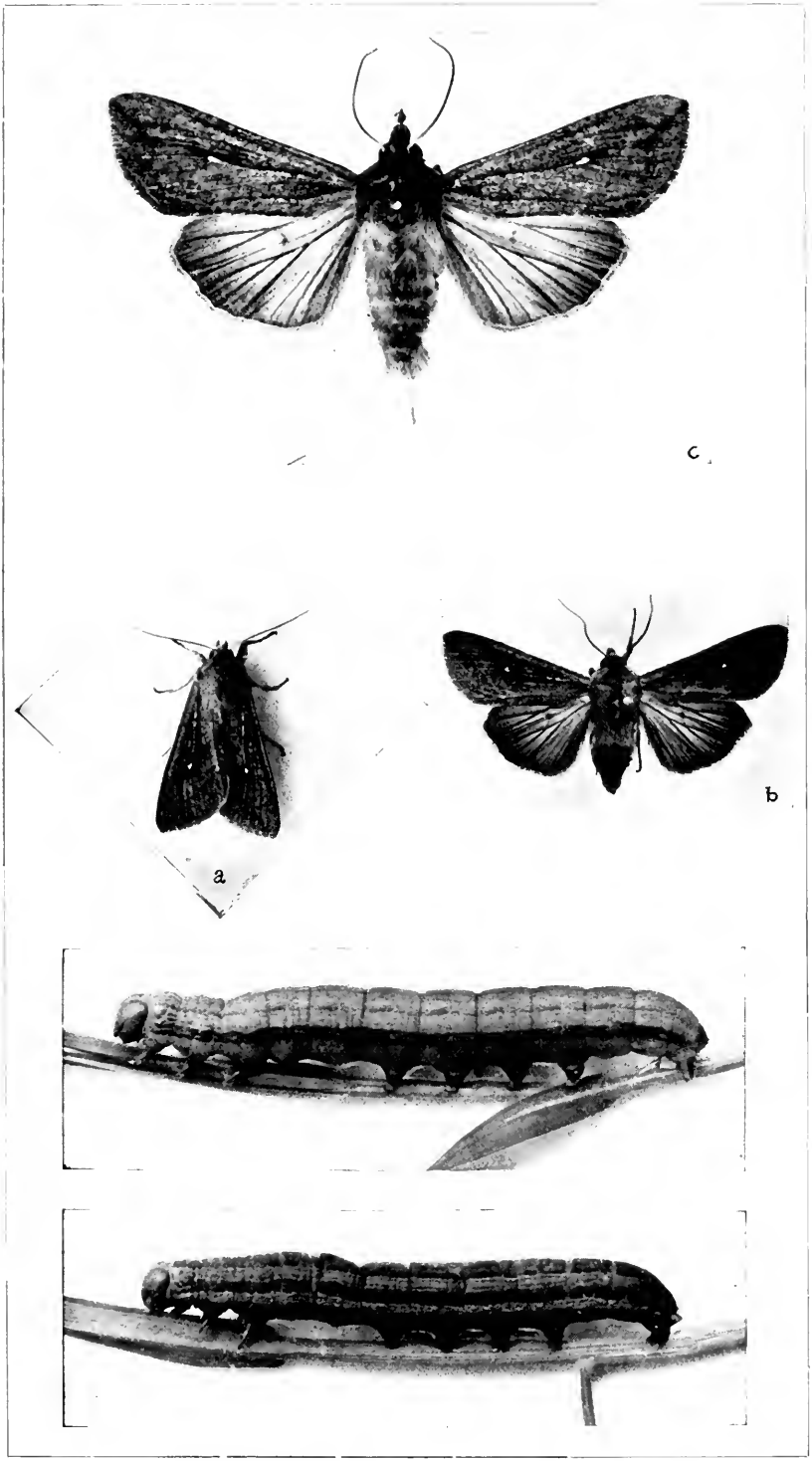
MYRIAPODA.

Leptodesmus falcatus *Lintn.*, a thousand-legged worm in greenhouses.
Polydesmus complanatus (*Linn.*), the flattened millipede.
Polydesmus serratus *Say*, the serrate Polydesmus.



The Great White Leopard Moth.

Army-Worms at Work on Corn.



Army-Worm Moths and Caterpillars.

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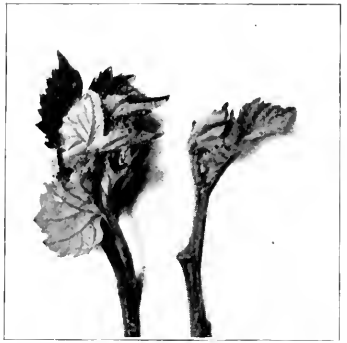

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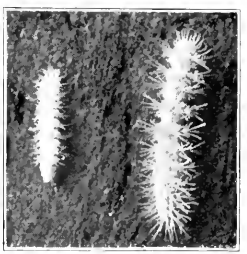

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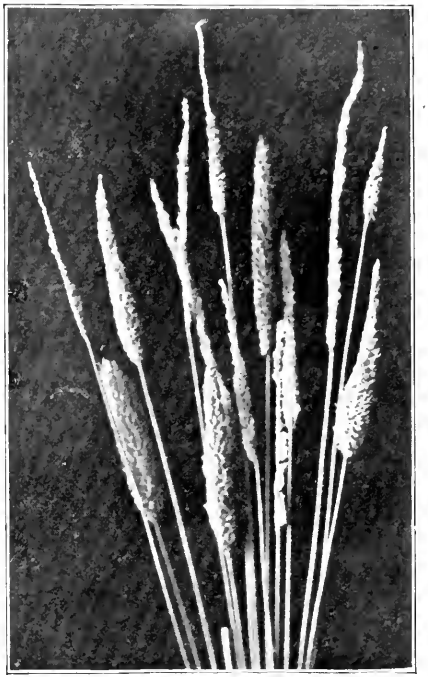

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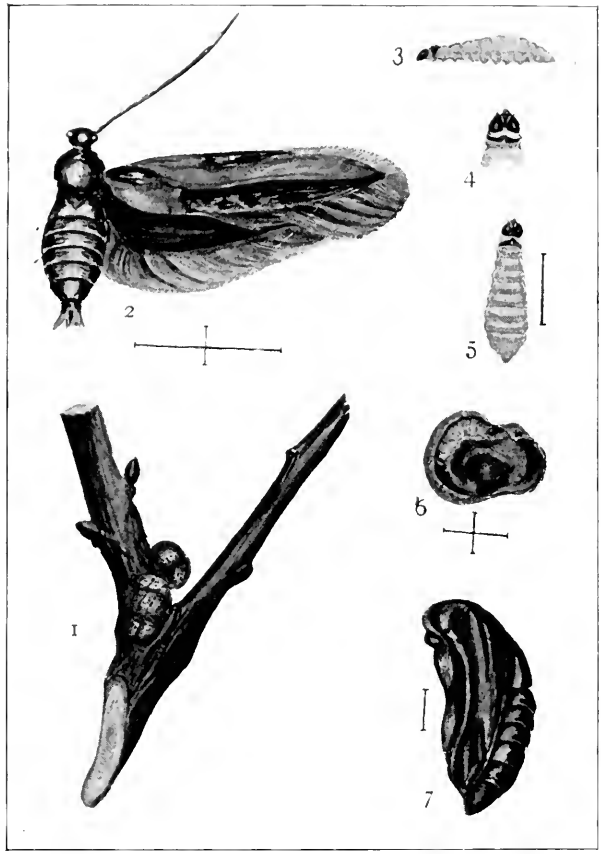
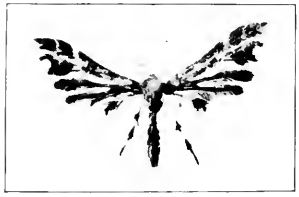
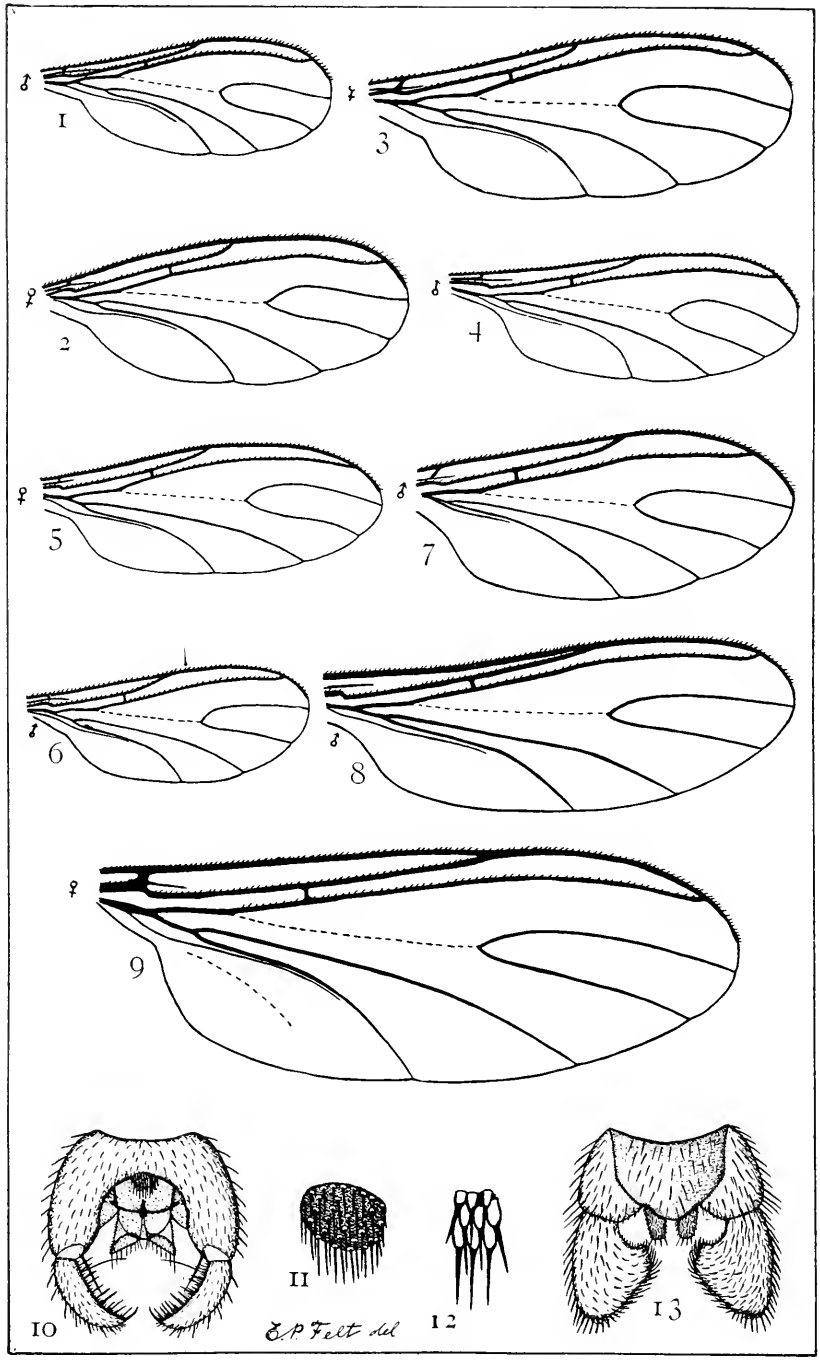
Ecpantheria Spines — Grape-vine Plume-moth — Work of Army-worm.

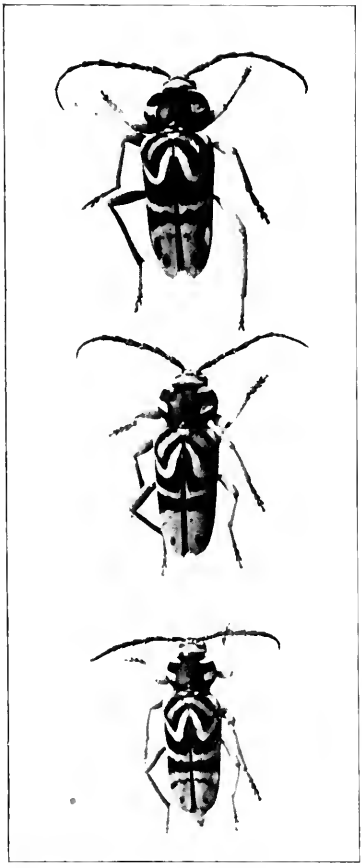




Kermes — Euclemensia — Oxyptilus.



New species of Sciara.



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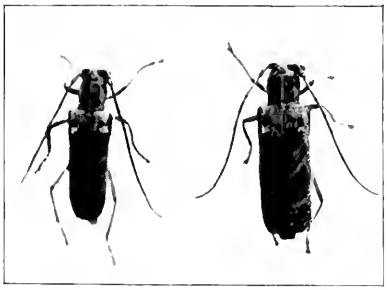

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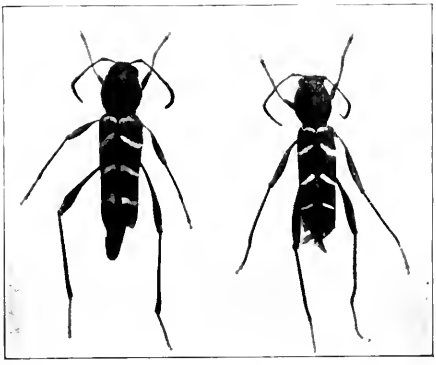

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Maple and Elm Tree Borers.

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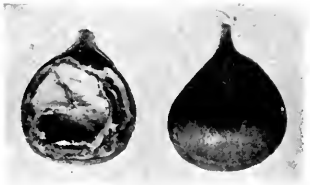

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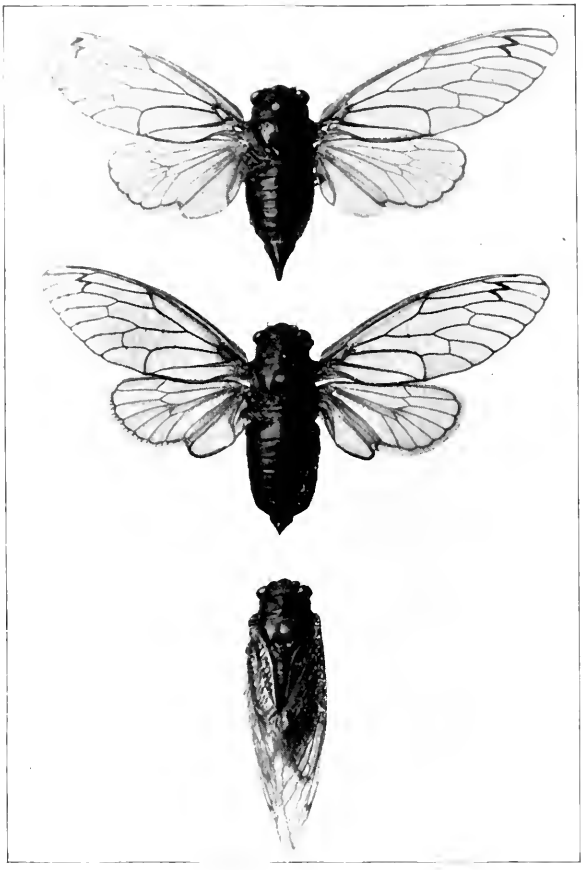
Elm and Locust Leaf Beetles, and Chestnut Weevil.



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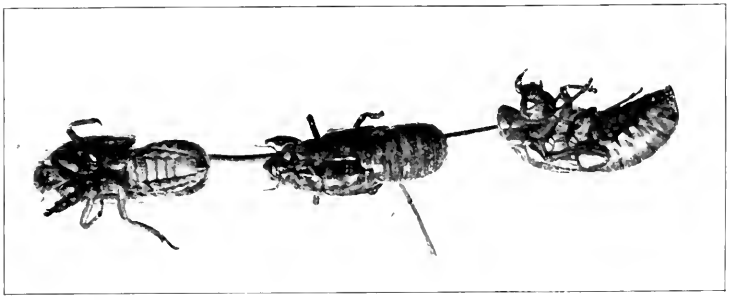

2

The Seventeen-year Cicada.

Cicada Chambers, at New Baltimore, N. Y.

Cicada Chambers.

Cicada Chambers, at New Baltimore, N. Y.

Cicada Chambers, at New Baltimore, N. Y.

2

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3

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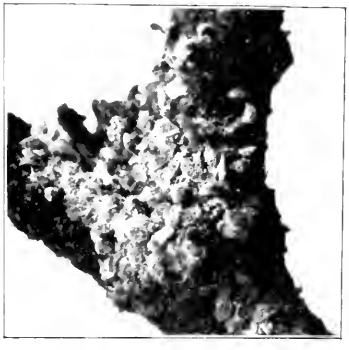
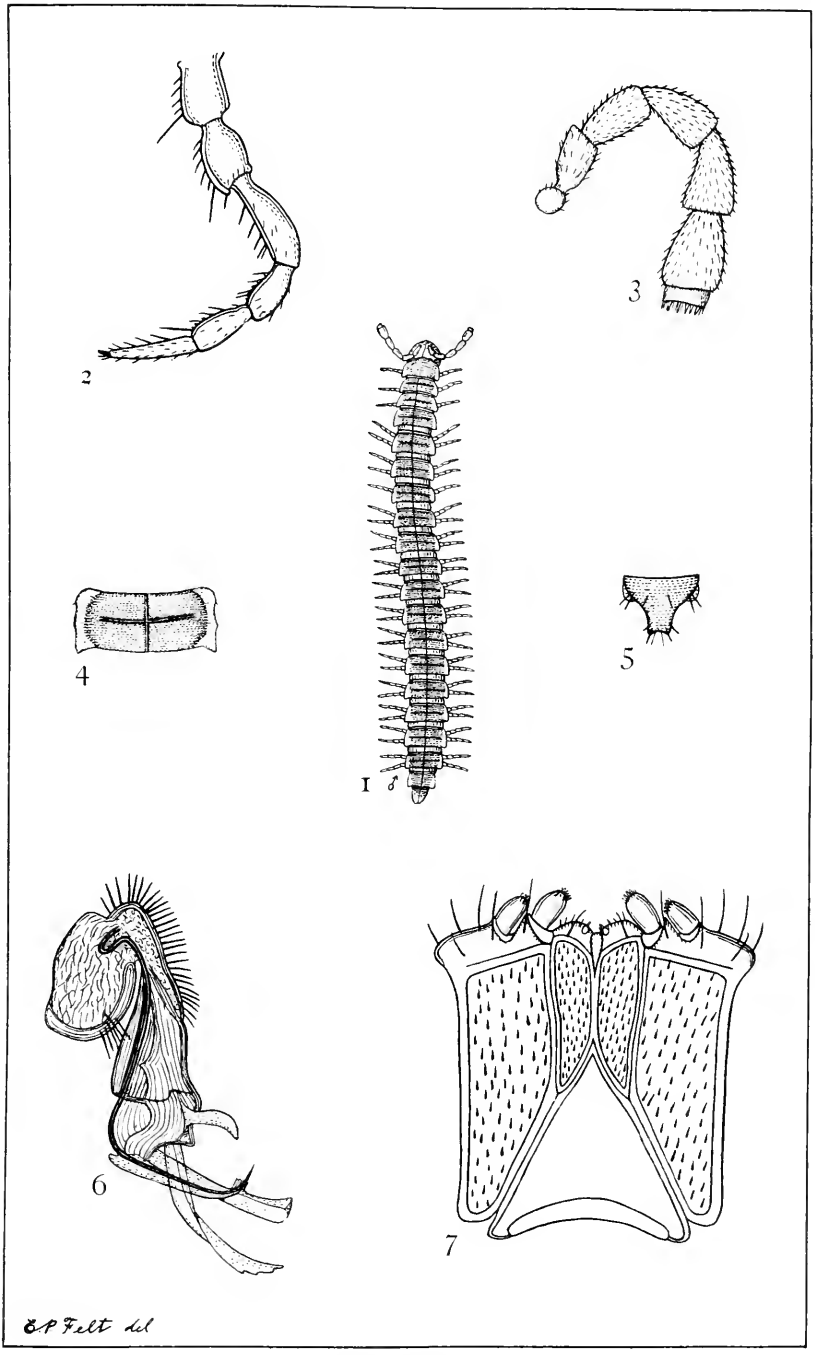


4

Pemphigus and Gossyparia.



Leptodesmus.

(F)

EXPLANATION OF PLATES.

Plates I, IV, V, VII, VIII, IX, XIV, are from photographs by E. P. Felt Plates X, XI, XII, XIII, are from photographs by W. W. Byington.

PLATE I.

Ecpantheria scribonia.

The Great White Leopard Moth.

The upper three figures are males; the lowest two, females: showing the variations in maculation in this species.

PLATE II.

Leucania unipuncta.

The Army-Worm

Army-worms at work on a corn plant, nearly natural size (after Slingerland).

PLATE III.

Leucania unipuncta.

The Army-Worm.

Fig. *a*.— Moth at rest, natural size; *b*, moth with wings expanded; *c*, moth twice natural size; lower figures, light and dark varieties of army-worms, twice natural size (after Slingerland).

PLATE IV.

Fig. 1 — Larval spines of *Ecpantheria scribonia*, thirty-five times natural size.

Fig. 2.—Heads of timothy eaten by army-worms, nearly natural size.

Fig. 3.—Tips of grape vines infested with larvæ of *Oxyptilus periscelidactylus*, natural size.

Fig. 4.— Young and nearly full-grown larvæ of *Oxyptilus*, about three times natural size.

Fig. 5.— Pupæ of same, about three times natural size

PLATE V.

Fig. 1.— *Kermes galliformis* on twig, natural size.

Fig. 2.— Imago of *Euclemensia Bassettella* (Clemens).

Figs. 3, 4, 5.— Larvæ of same.

Fig. 6.— Larva within the Kermes.

Fig. 7.— Pupa (Figs. 1 to 7 from colored drawings by W. R. Walton).

Fig. 8.— *Oxyptilus periscelidactylus*, twice natural size.

Fig. 9.— The same in natural position, twice natural size.

PLATE VI.

Fig. 1.— Wing of *Sciara multiseta*, male.

Fig. 2.— " " " female.

Fig. 3.— " *S. pauciseta*, female.

Fig. 4.— " " " male.

Fig. 5.— " *S. agraria*, female.

Fig. 6.— " " " male.

Fig. 7.— " *S. fulvicauda*, male.

Fig. 8.— " *S. prolifica*, male.

Fig. 9.— " " " female (Figs. 1 to 9 inclusive thirty-five times natural size).

Fig. 10.— Genitalia, dorsal aspect, of *S. agraria* (enlarged).

Fig. 11.— Group of setæ of *S. multiseta* (much enlarged).

Fig. 12.— Group of setæ of *S. pauciseta* (much enlarged).

Fig. 13.— Genitalia, dorsal aspect, of *S. fulvicauda* (enlarged).

PLATE VII.

Fig. 1.— *Plagionotus speciosus*; the upper two females, natural size.

Fig. 2.— *Saperda tridentata*, male and female, twice natural size.

Fig. 3.—*Neoclytus erythrocephalus*, male and female, twice natural size.

Fig. 4.— Work of *Saperda* and *Neoclytus* under the bark in elm, one-half natural size.

Fig. 5.— Cross-section of limb showing work of *Saperda* and *Neoclytus*, one-half natural size.

PLATE VIII.

Fig. 1.— Under surface of elm-leaf showing eggs, the larvæ and their work, of the elm-leaf beetle (nearly natural size); in the lower left-hand corner a group of eggs is represented three times natural size.

Fig. 2.— Locust leaves skeletonized by *Odontota dorsalis*, nearly natural size.

Fig. 3.— *Odontota dorsalis*, three times natural size.

Fig. 4.— Lateral view of male and female chestnut weevil, *Balaninus rectus*, twice natural size.

Fig. 5.— Chestnuts injured by weevil, one opened to show work inside, nearly natural size.

Fig. 6.— Dorsal view of female chestnut weevil, *Balaninus rectus*, twice natural size.

PLATE IX.

Cicada septendecim.

The Seventeen-Year Cicada.

Fig. 1.— Male and female with wings spread (the left fore-shortened in photographing); one with wings closed, nearly natural size.

Fig. 2.— Dorsal, lateral and ventral aspects of pupal shells, nearly natural size.

PLATE X.

Vertical views of Cicada chambers taken at New Baltimore, N. Y.; the lower one nearly one-half natural size, the upper one much reduced.

PLATE XI.

Cicada chambers collected at New Baltimore, nearly one-half natural size.

PLATE XII.

Cicada chambers at New Baltimore.

PLATE XIII.

Cicada chambers at New Baltimore, another view.

PLATE XIV.

Fig. 1.— Galls of *Pemphigus rhois*, natural size.

Fig. 2.— *Gossyparia ulmi*, full-grown females, taken June 7, slightly enlarged.

Fig. 3.— Male cocoons of *Gossyparia*, three times natural size.

Fig. 4.— Half-grown females of *Gossyparia*, taken Sept. 7, four times natural size.

Fig. 5.— Full-grown females of *Gossyparia*, about three times natural size.

PLATE XV.

Leptodesmus falcatus.

Fig. 1.— Male, three times natural size.

Fig. 2.— Leg (x 24).

Fig. 3.— Palpus (x 17).

Fig. 4.— Dorsum of segment (x 7).

Fig. 5.— Dorsum of terminal segment (x 7).

Fig. 6.— Lateral view of copulatory leg of male (x 65).

Fig. 7.— Gnathochilarium (x 35).

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ERRATA.

Page 197, line 3 from bottom, at end of line read : lying in.
Page 197, line 2 from bottom, for reportedon, read reported on.
Page 291, line 15, for Missouri read Illinois.
Page 308, line 10 from bottom, for current read currant.
Page 356, line 5 from bottom, for 238 read 243.
Page 357, line 9, for Birch-tree read Birch-seed.
Page 363, line 13, for beach read beech.
Page 363, line 15 from bottom, for FREEST read FREEST.

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